NATIONAL REPORT
FOR
THE CONVENTION ON NUCLEAR SAFETY

- The Fourth Review Meeting -

September 2007

THE REPUBLIC OF KOREA

The MOST/KINS Joint Working Group for the fourth CNS prepared this report on behalf of the Ministry of Science and Technology, Republic of Korea, in consultation with and incorporating contributions from organizations below.

Ministry of Science and Technology
Government complex, Gwacheon
Gyunggi-do, Korea 427-715
http://www.most.go.kr

Korea Institute of Nuclear Safety
POB 114, Yuseong
Daejeon, Korea 305-600
http://www.kins.re.kr

Korea Hydro & Nuclear Power Co., Ltd.
167 Samsung-dong, Gangnam-gu
Seoul, Korea 135-792
http://www.khnp.co.kr

Korea Atomic Energy Research Institute
POB 105, Yuseong
Daejeon, Korea 305-600
http://www.kaeri.re.kr

Korea Power Engineering Co., Ltd.
360-9 Mabuk-ri, Guseong-eup, Yongin
Gyunggi-do, Korea 449-713
http://www.kopec.co.kr

Doosan Heavy Industry and Construction Co., Ltd.
555 Guigok-dong, Changwon
Gyungsangnam-do, Korea 641-792
http://www.doosanheavy.com

ISBN 978-89-957325-5-7 93550 (Print, Korean)

ISBN 978-89-957325-6-4 93550 (Print, English)

ISBN 978-89-957325-7-1 98550 (e-book, Korean)

ISBN 978-89-957325-8-8 98550 (e-book, English)

Foreword

The ***Fourth*** National Report, pursuant to Article 5 of the Convention on Nuclear Safety which entered into force on October 24, 1996, describes the official actions that the Government of the Republic of Korea, as a signatory to the Convention, has taken in order to fulfill its obligations prescribed in Articles 6 through 19 of the Convention.

This National Report was prepared in accordance with the "Guidelines Regarding National Reports under the Convention on Nuclear Safety", reflecting the observations given in the Summary Report of the First, Second ***and Third Review Meetings.*** Revised and added parts as compared with the Second National Report were highlighted in bold and italics. The cutoff date of this national report preparation was ***December 31, 2006,*** otherwise specified in the report.

Nuclear installations covered in this report are land-based civil nuclear power plants in the Republic of Korea, including such storage, handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of nuclear power plants, as defined in Article 2 of the Convention.

This National Report was drafted by the "Working Group for the Implementation of the Convention on Nuclear Safety" organized by Ministry of Science and Technology, in collaboration with the Ministry of Foreign Affairs and Trade. This Report was reviewed by relevant governmental and industrial organizations, and deliberated over by the Nuclear Safety Commission.

Major contributors to the preparation of this National Report were as follows: Mr. B.R. Moon, Mr. P.W. Han, Mr. Y.E. Choi of Ministry of Science and Technology; Mr. H.K. Kim, Mr. K.W. Cho, Ms. Y.H. Hah, Mr. D.H. Kim, Mr. W.S. Kim, Mr. K.S. Choi, Mr. Y.S. Choi, Mr. J.T. Ha, Mr. S.W. Kim, Mr. D.H. Lee, Mr. S.W. Kim, Mr. K.Y. Sung, Mr. B.S. Lee, Mr. S.J. Yoo, Mr. D. Lee, Mr. H.W. Lee, Mr. D.H. Lee of the Korea Institute of Nuclear Safety; Mr. K.H. Koo, Mr. M.S. Kwon, Mr. H.G. Yun of the Korea Hydro & Nuclear Power Co., Ltd.; and Mr. K.H. Jang of the Korea Power Engineering Company; Mr. S.K. Kim of Doosan Heavy Industry Co., Ltd.; Mr. T.W. Kim of Korea Atomic Energy Research Institute.

Table of Contents

I. Introduction

II. Article-by-Article Assessment

A. General Provisions

B. Legislation and Regulation

C. General Safety Considerations

D. Safety of Installations

III. Planned Activities to Improve Safety

IV. Measures taken for the Observations and Recommendations in Summary Report of the *Third* Review Meeting

Annexes

List of Tables

List of Figures

List of Acronyms

AAC	Alternate Alternating Current
ABB-CE	Asea Brown Boveri-Combustion Engineering
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
ASME	American Society of Mechanical Engineers
B&PV	Boiler & Pressure Vessel
CANDU	CANada Deuterium Uranium
CARE	Computerized Technical Advisory System for the Radiological Emergency
CDF	Core Damage Frequency
CP	Construction Permit
DHICO	Doosan Heavy Industries Company
e-FAST	electronic Functional Analysis & Simulation Tool
EOF	Emergency Operations Facility
EPZ	Emergency Planning Zone
ERF	Emergency Response Facility
HPES	Human Performance Enhancement System
HPSI	High Pressure Safety Injection
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
INES	International Nuclear Event Scale
INPO	Institute of Nuclear Power Operations
ISI	In-Service Inspection
IST	In-Service Test
KAERI	Korea Atomic Energy Research Institute
KEDO	Korean Peninsula Energy Development Organization
KEPCO	Korea Electric Power Corporation
KHNP	Korea Hydro & Nuclear Power Company, Limited
KINAC	***Korea Institute of Nuclear Nonproliferation And Control***
KINS	Korea Institute of Nuclear Safety
KISOE	Korea Information System on Occupational Exposure
KNFC	Korea Nuclear Fuel Company
KNS	Korean Nuclear Society

KOPEC	Korea Power Engineering Company
KPS	Korea Plant Service and Engineering Company
KRIA	Korea Radioisotopes Association
LEMC	Local Emergency Management Center
LPSI	Low Pressure Safety Injection
LWR	Light Water Reactor
MOCIE	Ministry of Commerce, Industry and Energy
MOE	Ministry of Environment
MOST	Ministry of Science and Technology
MOU	Memorandum of Understanding
NEED	Nuclear Event Evaluation Database
NEMC	National Emergency Management Committee
NGO	Non-Governmental Organization
NPP	Nuclear Power Plant
NSC	Nuclear Safety Commission
NSIC	Nuclear Safety Information Center
ODCM	Off-site Dose Calculation Manual
OEMC	Off-site Emergency Management Center
OL	Operating License
OPIS	Operational Performance Information System
OSC	Operational Support Center
PHT	Primary Heat Transport
PHWR	Pressurized Heavy Water Reactor
PNSC	Plant Nuclear Safety Committee
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PWR	Pressurized Water Reactor
SAR	Safety Analysis Report
SDA	Standard Design Approval
SDR	Special Drawing Right
SPDS	Safety Parameter Display System
SPI	Safety Performance Indicators
TLD	Thermoluminescence Dosimeter
TSC	Technical Support Center
USNRC	US Nuclear Regulatory Commission
W/H	Westinghouse Electric Company

I. Introduction

I.1 National Nuclear Energy Policy

I.1.1 Long-term Nuclear Energy Policy

The Korean Government has maintained a consistent national policy for stable energy supply by fostering nuclear power industries, under the circumstances that energy resources are insufficient in the country. Kori Unit 1, the first nuclear installation in Korea, started its commercial operation in 1978. ***As of December, 2006 there are 20 units in operation and 2 units under construction; in addition, 6 units are under planning for construction, as shown in Figure I.1-1 and Annex A.***

The necessity of promoting a comprehensive and consistent policy has increased with the expansion of the nuclear industry, since the beginning of the 1990's. The Atomic Energy Commission (AEC), in consideration of such changes in situations, deliberated and decided on the "Directions of Long-term Nuclear Energy Policy towards the Year 2030" in July 1994.

In order to offer a legal basis for effectively implementing the aforementioned directions of long-term nuclear energy policy, the Government legislated for the particulars on the "Formulation of a Comprehensive Promotion Plan for Nuclear Energy" through the amendment to the Atomic Energy Act in January 1995. As a national plan, “the First Comprehensive Promotion Plan for Nuclear Energy (1997-2001)” and "the Second Comprehensive Promotion Plan for Nuclear Energy (2002-2006)" were formulated through the decision of the AEC in June 1997 and July 2001, respectively.

In January, 2007, “the Third Comprehensive Promotion Plan for Nuclear Energy (2007-2011)” was also formulated through the decision of AEC. “The Third Comprehensive Promotion Plan for Nuclear Energy” has been established from the evaluation of accomplishments of the first and the second plans, and is based on the current status and prospect on using nuclear energy safety management. In addition, it presents a vision for nuclear energy policy as well as 6 goals for the policy

with promotion subject focus for each goal by 2011. The plan reflects Nuclear Technology Road Map (NuTRM) that was established in 2005 to institute a long-term vision for the R&D activities of national nuclear energy industry and the systematic promotion strategy and to develop strategic technologies and products.

The vision and six goals for the policy of "The Third Comprehensive Promotion Plan for Nuclear Energy" are shown in Figure I. 1-2.

I.1.2 Nuclear Safety Policy

In September 1994, the Minister of Science and Technology issued the "Statement of Nuclear Safety Policy" containing 5 principles of nuclear safety regulation to secure consistency, adequacy, and rationality of regulatory activities, and 11 directions of nuclear safety regulation policy to concretely implement those principles. (Refer to Annex B)

The Statement of Nuclear Safety Policy declares that securing safety is a prerequisite to the development and utilization of nuclear energy, and that all workers engaged in nuclear activities must adhere to the principle of "priority to safety." It emphasizes the importance of developing the nuclear safety culture that the International Atomic Energy Agency (IAEA) has referred to. It also prescribes that the ultimate responsibility for nuclear safety rests with the operating organizations of nuclear installations, and is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors, or regulators. Finally, it prescribes that the Government shall fulfill its overall responsibility to protect the public and the environment from radiation hazards that might accompany the development and utilization of nuclear energy.

In order to assure the institutional independence of nuclear safety regulation, the Government established the Nuclear Safety Commission (NSC) through the amendment to the Atomic Energy Act in December 1996. Its function is to deliberate and decide on important issues related to nuclear safety. It is under the jurisdiction of the Minister of Science and Technology and independent of the AEC.

The Ministry of Science and Technology (MOST) has been directing the nuclear safety regulation policy to ensure consistent and transparent regulation from the

beginning of every year since 2002 through the deliberation of the NSC. The direction of the policy presents the governmental plans to improve nuclear safety by prioritizing items. It is based on the analysis of domestic and international activities and the evaluation of accomplishment of safety regulation from the previous year. The MOST confirms the fact that the safety always has the top priority every year through the policy direction. Main items concerning the policy direction in each year are summarized in Table I.1-1.

I.2 National Nuclear Power Development Program

The government had updated the Long-term Electricity Supply Plan every 2 years, since its formulation in 1991. In accordance with the revision of relevant laws for the Restructuring of Electric Industry in Korea, it was reformulated to Basic Electricity Supply Plan in August, 2002. ***"The Second Basic Electricity Supply Plan (2004~2017)" and "The Third Basic Electricity Supply Plan (2006~2020)" were established in December, 2004 and December, 2006, respectively.***

The installed capacity and power generation of ***the third*** nuclear installations are shown in Table I.2-1.

In the restructuring process of electric industry in Korea, hydro & nuclear parts had been separated from Korea Electric Power Corporation (KEPCO) which was the owner of all power plants in Korea and Korea Hydro & Nuclear Power Co., Ltd (KHNP) was established in April, 2001. KHNP, a subsidiary of KEPCO, constructs and operates all of the hydro and nuclear power plants in this country.

I.3 Summary of Main Safety Issues

In order to complement any deterioration in safety due to the aging of structures, systems, and components of operational nuclear installations and to ensure a high level of safety commensurate with new installations**,** MOST devised institutional measures to conduct a comprehensive periodic safety review in addition to the existing safety assessment and inspection for operating nuclear installations (Refer to Section III.1).

In order to utilize the risk information, Korea Institute of Nuclear Safety (KINS) has been implementing the application items from research of regulation field in stages. The operator, KHNP, is also performing actions necessary to utilize the risk information and prepare risk informed regulations (refer to Section III.2).

The government is implementing diversified campaign such as events at Nuclear Safety Day every year, awarding Nuclear Safety Mark quarterly and events at Nuclear Safety Alert Day every month to awaken and strengthen safety consciousness among nuclear industries and also encourage people working in the area of nuclear safety. (Refer to Appendix E)

The government has reorganized the laws on safety management plan for the nuclear power plants of which operation period exceeds their designed lifetime. The laws enable continued operation after confirming the safety through periodic safety review, the time limited ageing analysis of major components, the improved ageing management program and the radiological environment effect evaluation. In addition, the Government has determined the technical standards on specific items required for safety evaluation. KHNP applied a continued operation according to the related laws for Kori Unit 1 in June, 2006. Currently, KINS is reviewing the application.

The Government is currently performing a technical review for the power uprate of the nuclear power plants. The power uprate can be achieved by improving the efficiency and performance of the secondary system by maintaining the safety and performance margins. KINS completed the review for Kori Unit 3, 4 in December, 2006 and it is processing the review for Yonggwang Unit 1, 2. The effects on the safety and performance of existing design due to power uprate are analyzed during the review process. The analysis includes the evaluation of safety margins from accident analysis result and of engineering margins from component analysis for the first and secondary system, material integrity, set point of safety system and changes in set point of operation control. The MOST plans to confirm the safety and performance by regulatory inspection on the actual systems and operation changes. It will be completed before the actual power uprated operation.

Table 1.1-1 Main Items Concerning Policy Direction

Year	*Approval date*	*Basic direction*	*Main policy*
2002	*Jan. 22., 2002*	*Attain and enhance the nuclear safety through predictable, efficient regulation for the public's ease*	*- Establish an advanced safety regulation framework* *- Enhance the radiation and radioactive substance safety management* *- Establish a national radiological emergency response scheme* *- Strengthen the safety infrastructure and foster a safety culture* *- Obtain LWR safety assistance for North Korea and expansion of international cooperation*
2003	*Jan. 27., 2003*	*Attain nuclear safety administration for the public's ease*	*- Strengthen a nuclear accident/incident prevention framework* *- Develop a scientific/rational nuclear safety regulation regime* *- Establish a world-class nuclear safety regulation regime* *- Promote public participation in nuclear safely regulation* *- Strengthen a user-friendly safety management regime for radioisotope* *- Expand the basis of a national radioactivity disaster prevention framework* *- Establish a nuclear safety regulation infrastructure*
2004	*Feb. 6., 2004*	*Achieve nuclear safety administration that ensures the public's ease through instating a cutting edge nuclear safety management system*	*- Scientifically rationalize the NPP safety management* *- Strengthen the national radiation safety management framework* *- Expand the radioactivity terrorism and disaster prevention framework* *- Publicize the nuclear safety culture*

2005	***Jan. 26., 2005***	***Realize the nuclear safety administration for the public's ease***	***- Establish the general, comprehensive and responsible safety regulation - Develop an innovative and leading safety regulation - Strengthen the national radiation safety management framework - Substantiate the radioactivity disaster prevention and counter-terrorism framework - Enhance the public confidence and promote the safety culture - Take a leading role in the international society***
2006	***Mar. 13., 2006***	***Secure the public confidence and the highest level of nuclear safety through a high quality safety regulation***	***- Administer a field-centered safety management using up-to-date regulation methods - Secure a thorough safety confirmation on new regulation subjects - Establish the basis for field-centered comprehensive nuclear protection and disaster prevention - Establish and implement a safety regulation quality management framework - Promote safety regulation to familiarize the public - Strengthen nuclear safety cooperation with the international society***
2007	***Dec. 6., 2006***	***Fortify the public confidence through securing the world class nuclear safety***	***- Maintain a ultimate nuclear safety level - Continue to enhance the safety regulation system and framework - Upgrade the safety regulation technology and promote the globalization - Promote the safety culture and fortify the public confidence***

Table I.2-1 Installed Capacity and Power Generation in NPPs

Items \ Year	2000	2005	***2010 (Plan)***	***2020 (Plan)***
Number of operating units	16	20	***21***	***28***
Generating capacity in MWe (%)	13,716 (28.3)	17,716 (28.6)	***18,720 (23.9)***	***27,320 (29.0)***
Power generation in GWh (%)	108,964 (40.9)	134,083 (38.8)	***146,752 (32.3)***	***225,063 (43.4)***

Source: ***The Third Basic Electricity Supply Plan, Ministry of Commerce, Industry and Energy , December 2006.***

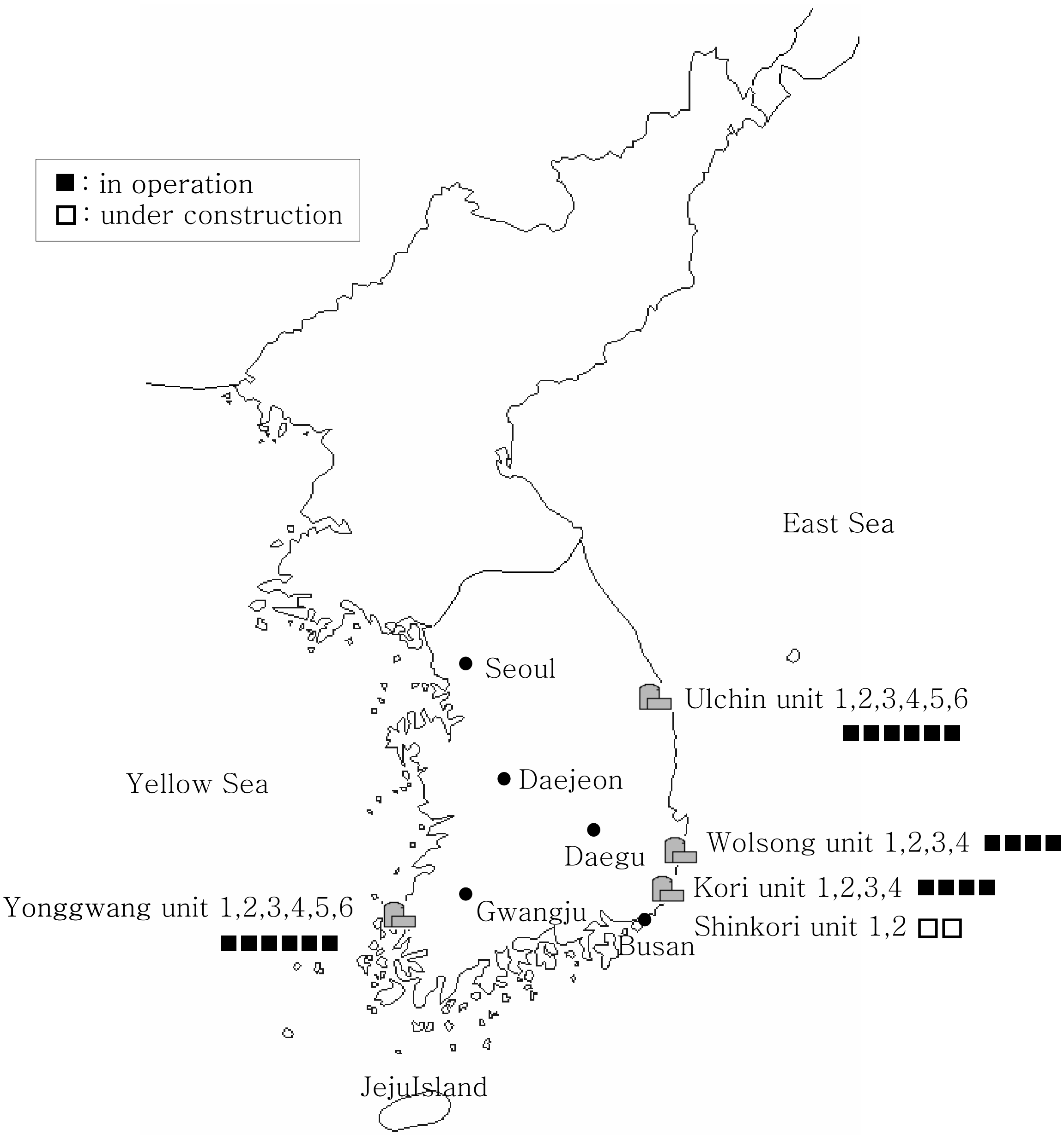


Figure I.1-1 Locations of Nuclear Installations (*as of December, 2006*)

Vision

Contributing to energy security, environmental protection, promotion of quality of life, and development of science and technology
- Nuclear power as driving force of Korea's future -

Policy goal

1. Keeping nuclear energy supply stable for sustainable development
2. Continuing safety improvement to gain public consensus on nuclear program
3. Securing international competitiveness of nuclear technology to foster export
4. Expanding the use of radiation technology for the promotion of public health and quality of life
5. Establishing base infrastructure for efficient development and utilization of nuclear energy technology
6. Enhancing national status in nuclear energy field through nuclear diplomacy and international cooperation

Figure I.1-2. The Vision and Six Goals of the Policy in The Third Comprehensive Promotion Plan for Nuclear Energy

II. Article-by-Article Assessment

A. General Provisions

II.1 Existing Nuclear Installations (Article 6)

II.1.1 Status of Nuclear Installations

The status of the construction and operation of nuclear installations is shown in Annex A. Kori Unit 1, the first nuclear power plant in Korea, started its commercial operation in April 1978. As of ***December 2006,*** there are ***20*** units of nuclear power plant in operation and ***2 units*** under construction**.** The ***20*** operating units consist of ***16*** Pressurized Water Reactor (PWR)-type units and 4 Pressurized Heavy Water Reactor (PHWR)-type units, while ***2*** units under construction are of PWR type.

II.1.2 Safety Assessment for Nuclear Installations

Safety Assessment and Inspection for Pre-operational Nuclear Installations

The Atomic Energy Act stipulates that an applicant for a construction permit (CP) or an operating license (OL), before commencing the construction and operation of nuclear installations, shall perform comprehensive and systematic safety assessments and file safety analysis reports (SARs) with the regulatory body for a safety review. According to this provision, all nuclear installations are under construction and in operation through safety assessment by the KHNP as an applicant for CP and OL, and through safety review and regulatory inspection by MOST as a regulatory body. The details of the stepwise safety review and regulatory inspection and the general licensing procedure for the operation of nuclear installations are described in Section II.2.3 and II.2.4, while the details of the comprehensive safety assessment for the construction and operation of nuclear installations are described in Section II.9.1.

Safety Assessment and Inspection for Operational Nuclear Installations

KHNP, the operator of nuclear installations, conducts a safety assessment for the refueled reactor core at every refueling period. MOST approves the criticality of NPP only when the result of a comprehensive safety and performance evaluation for nuclear installations is satisfactory through a systematic regulatory inspection as well as a safety review. The details of a safety assessment for operational nuclear installations are described in Section II.9.2.

In order to ensure the safety of operating nuclear installations, KHNP carries out an overall safety examination for nuclear installations every 20 months, and improve the safety of the nuclear installation, if necessary, as a result of the evaluation of safety-related operating experience and incident cases. KHNP also conducts a periodic assessment for the main safety parameters, for example, unplanned reactor scram, and the operability of safety-related facilities. The specific activities are described in Section II.9.2 and II.9.3.

KHNP performs Periodic Safety Review (PSR) for all nuclear power plants every 10 years after the commencement of their commercial operation and submit the reports to MOST. MOST reviews the results of utility's safety review and its plans for enhancing nuclear safety. Details of PSR are described in Section II.9.2 and III.1.

Probabilistic Safety Assessment for Nuclear Installations

To comprehensively evaluate the safety of operational nuclear installations and to identify the vulnerabilities to severe accidents, MOST recommended KHNP to perform a probabilistic safety assessment for each nuclear installation. In response thereto, KHNP completed or is now conducting the probabilistic safety assessment for relevant installations. The particulars of the status of implementing probabilistic safety assessment and the core damage frequency are described in Section II.9.2.

Severe Accidents Management

MOST took measures to lower the risk of nuclear installations as low as possible in view of the defense in depth concept by conducting Probabilistic Safety Assessment (PSA) for individual power plant against severe accident which may cause a damage of reactor core and/or the release of radioactive materials to the environment. In ***August,*** 2001, the NSC decided to formulate a severe accident policy which establishes quantitative safety goal and reactor performance goal and recommends the evaluation of NPP's risk with PSA methodology**.**

The policy also requires licensee's capability to prevent severe accident and the establishment of severe accident management program ***(refer to Annex D).***

Accordingly, KHNP has established and applied the severe accident management programs for 14 units among the 20 operating units. The severe accident management programs are under development for 2 plants, and under plan for the remaining 4 plants.

Safety Improvement of Nuclear Installations

The safety vulnerability observed by the aforesaid safety assessments continues to be rectified through the improvement of installation, maintenance, and the modification of a relevant procedure. In fact, KHNP applied the Post-TMI Actions to all nuclear installations under construction or in operation, after the TMI nuclear accident in USA. As for the Kori Unit 1 which started operation first in Korea in 1978, ***KHNP replaced the steam generator in Kori Unit 1 in 1998 and the generators in Ulchin Unit 1 & 2 are in process for replacement. In addition, KHNP strives for continuous enhancement of the safety of nuclear installations by reinforcing equipments for possible power outage in all nuclear power plants and by replacing the pressure tubes of Wolsong Unit 1, PHWR, etc.***

II.1.3 Safety Status of Nuclear Installations

Through various types of systematic assessments for operating nuclear installations and continuous efforts to enhance safety, as mentioned above, the nuclear installations in operation show high performance in terms of unplanned scram rates, capacity factors and occupational radiation exposures as described in Section II.9.2.

Consequently, the safety level of operating nuclear installations is in conformity with the international safety criteria and practices prescribed in Articles 10 to 19 of the

Convention. Currently, there are no pending issues which require urgent special measures to enhance safety.

On the other hand, there were several accidents from 2004 to 2006. A fire broke out in the containment building during the planned overhaul outage at Kori Unit 4 in February 2006. In October 2006, in Ulchin Unit 2, a reactor came into the sub-criticality due to a malfunctioning of a pressurizer spray valve. KHNP responded promptly in accordance with the procedures to prevent the general public and the environment from being affected by the radiation. Regulatory body also responded adequately to those events and performed safety assessments and inspections, and took proper regulatory measures to enforce KHNP to take actions to prevent occurrences of similar events. Overviews of those events are provided in Annex ***G***.

II.1.4 Position as to Continued Operation of Nuclear Installations

Based on the result of various evaluations, the Korean Government concludes that the continued operation of operational nuclear installations is reasonable.

B. Legislation and Regulation

II.2 Legislative and Regulatory Framework (Article 7)

II.2.1 Nuclear Legislative Framework

Atomic Energy Act

National laws related to the development, utilization and safety regulation of nuclear energy are the Atomic Energy Act, the Electricity Business Act, the Basic Law of Environmental Policy and others shown in Table II.2-1. All provisions on nuclear safety regulation and radiation protection are entrusted to the Atomic Energy Act. The Atomic Energy Act was enacted as the main law concerning safety regulations of nuclear installations.

The Atomic Energy Act system, as shown in Figure II.2-1, consists of 4 stages: the Atomic Energy Act, the Enforcement Decree of the same Act, the Enforcement Regulations of the same Act and the Notice of the Minister of Science and Technology. The Atomic Energy Act provides the bases and the fundamental matters concerning the development and utilization of nuclear energy and safety regulation. It includes provisions on the AEC, the NSC, nuclear energy promotion program, CP and OL of nuclear installations, and others shown in Table II.2-2.

The Enforcement Decree of the same Act (the Presidential Decree) provides the technical standards and administrative procedures or methods necessary for the enforcement of the same Act.

The Enforcement Regulation of the Act (the MOST Ordinance including Enforcement Regulation Concerning the Technical Standards of Reactor Facilities, etc., and the Enforcement Regulation Concerning the Technical Standards of Radiation Safety Management, etc.) provides the particulars including the detailed procedure, the format of documents, and technical standards, as entrusted by the same Act and the same Decree.

The Notice of the Minister of Science and Technology prescribes specific issues including regulatory requirements and technical standards, as entrusted by the same Act, the same Decree and the same Regulation. Table II.2-3 lists the Notices of the Minister of Science and Technology applicable to nuclear installations.

In 2005, the MOST set up the legal foundation for establishing the Korea Institute of Nuclear Nonproliferation And Control (KINAC) and for continued operation of nuclear power plants with operation period that exceeds their designed lifetime. KINAC was established in June 2006 as an expert organization for physical protection and effective promotion of the safeguard of nuclear facilities and nuclear materials and for the control of export and import. In addition, the MOST took charge of the inspections on the secondary system on which the Ministry of Commerce, Industry and Energy had previously performed. During the period of 2004 to 2006, 5 notices were newly formulated and 12 notices were amended (refer to Table II.2-3).

The industrial standards applicable to nuclear activities are endorsed by MOST and applied to the design and operations of nuclear installations. The guidelines on safety reviews and regulatory inspections, developed by KINS, an expert organization for safety regulation, are in practical use.

Physical Protection and Radiological Emergency Act

To strengthen physical protection system for nuclear material and nuclear facilities and radiological disaster management system, the "Act on Physical Protection and Radiological Emergency" was passed in May 2003. Many articles concerning physical protection and radiological disaster prevention in the Atomic Energy Act were moved into this Act and many new articles were put into this Act to implement various countermeasures for physical protection and against a radiological emergency. The details thereof will be described in Section II.11.

Nuclear Liability Related Laws

With regard to the utility's civil liability for any nuclear accident, the "Nuclear Liability Act" and the "the Act on Indemnification Agreement for Nuclear Liability" were established in 1969 and in 1975, respectively, for i) the proper compensation for the victims and ii) the sound development of nuclear industries, and they prescribes a general principle internationally adopted concerning the civil liability for nuclear damage. In order to reflect the spirit of the Vienna Convention revised in 1997, the Nuclear Liability Act was amended on January 16, 2001.

In the amended Act, the definition of "nuclear damage" was more specified. The limit on the liability amounts of 300 million SDR (Special Drawing Right) was introduced and the ceiling of financial security was increased to 300 million SDRs, etc. Under the ceiling, specific amount to be secured is given in the presidential decree. According to the decree, the amount of financial security for one site of nuclear power plants is 50 billion Korean won ***at the end of 2006***.

In 2006, the "earthquake" was appended to the application range in the amended Decree of Act on Indemnification of Nuclear Liability.

II.2.2 Nuclear Regulatory Framework

The governmental organizations concerned with nuclear activities, as shown in Figure II.2-2 are mainly formed of administrative authorities: The Ministry of Commerce, Industry and Energy (MOCIE) supervising the nuclear power program, the Ministry of Environment (MOE) responsible for regulating issues on the general environment excluding the radiological environment, and MOST responsible for nuclear safety regulations including the licensing of nuclear installations. There is also the AEC under the jurisdiction of the Prime Minister, as the supreme organization for decision making on national nuclear policy. Its responsibility is to deliberate and decide on important matters concerning the development and utilization of nuclear energy. And lastly, the NSC, under the jurisdiction of MOST is responsible to deliberate and decide on important matters concerning the safety of nuclear installations.

Nuclear safety regulatory organizations, as shown in Figure II.2-3, are mainly composed of MOST and the NSC as a safety regulatory authority, and KINS as a safety regulatory expert body. In August 2001, MOST has established Nuclear Emergency Division within Atomic Energy Bureau. In 2003, the Off-site Emergency Management Center was also established near nuclear power plant site (Figure II.2-3). In addition, there are two organizations supporting regulatory activities of MOST, namely, the Korea Atomic Energy Research Institute (KAERI) and the Korea Radioisotopes Association (KRIA) which transact the trusted affairs relevant to legal retraining for the radiation workers. The KRIA is in charge of maintaining and keeping the related documents to occupational radiation exposures of the radiation worker. The details of regulatory organizations are described in Section II.3.

In 2006, Korea Institute of Nuclear Nonproliferation And Control (KINAC) was established as an expert organization for the physical protection, safeguard of nuclear facilities including nuclear materials and for the control of export and import.

II.2.3 Licensing System and Safety Assessment

The licensing procedures of nuclear installations consist of two steps, the CP and the OL, pursuant to the Atomic Energy Act, and the early site approval system is established as a line in the chain of CP, as shown in Figure II.2-4.

Standard Design Approval (SDA)

For the standard design of the NPPs which have enhanced level of safety, the regulatory effectiveness has been improved by setting up a new licensing system, i.e. the Standard Design Approval (SDA) System. The SDA system will ensure the validation of approved standard design without imposing additional regulatory requirements during a certain period of time by the law and will basically exclude safety review for the portions of NPPs referencing approved standard design.

Early Site Approval

In order to begin limited construction work on a proposed site before the CP is issued, an applicant for early site approval shall file an application for approval accompanied by a site survey report and a radiological environmental report with the Minister of Science and Technology. Based on the results of the safety review by KINS of the application for early site approval, the Minister will grant official approval. The objective of the safety review is to evaluate the adequacy of a nuclear site and the radiological impacts on the environment surrounding the nuclear installation. MOE is in charge of reviewing non-radiological environmental impacts.

Construction Permit (CP) for Nuclear Installation

In order to obtain a CP for nuclear installation, the applicant shall file an application for a CP accompanied by the radiological environmental report, the preliminary SAR, and the quality assurance program for construction with the Minister of Science and Technology. Basing on the results of the safety review by KINS of the application for a CP, the Minister will issue a CP after deliberation by the NSC.

The safety review of the application for a CP is conducted to confirm that the site and the preliminary design of the nuclear installation are in conformity with the relevant regulatory requirements and technical guidelines. It includes safety reviews of the principle and concept of reactor facility design, the implementation of the regulatory criteria in due course, the evaluation of the environmental effects resulting from the construction, and a proposal for minimizing those effects.

The radiological environmental report to be filed together with the application for a CP as well as for early site approval should contain the public's opinion from the area surrounding the nuclear installation through a public hearing, if necessary.

Operating License (OL) for Nuclear Installation

To obtain an OL for a nuclear installation, the applicant shall submit to the Minister of Science and Technology the application for an OL accompanied by the operational technical specifications, the final SAR, the quality assurance program for operation, and the ***radiological environmental report***. Based on the results of the safety review by KINS of the application for an OL and the results of pre-operational inspections, the Minister will issue the OL after deliberation by the NSC.
The safety review of the application for an OL is conducted to confirm that the final design of the nuclear installation is in conformity with the relevant regulatory requirements and technical guidelines and that the nuclear installation may continue to operate throughout its lifetime.

Amendment to OL for Nuclear Installation

In order to make modifications to the specifics for which the OL has been given, such as a change in the operational technical specifications or in the design that affects or may affect the safety of operating nuclear installations, it is necessary to obtain approval from the Minister of Science and Technology for an amendment to the OL. The approval for an amendment to the OL is the same in procedure as the application for an OL. A safety review is to be conducted for the parts whose safety is affected or may be affected by the amendment to the OL.

Approval for Decommissioning of Nuclear Installation

In case that an operator intends to decommission a nuclear installation, the operator shall prepare a decommissioning plan and obtain prior approval from the Minister of Science and Technology. A safety review for approval of the application is to be conducted by KINS for the radiation protection during decommissioning, the radiological impacts on the environment surrounding the nuclear installation after decommissioning, and the proposal for minimizing the impacts.

II.2.4 Regulatory Inspection

Regulatory inspections for a nuclear installation under construction or in operation include the pre-operational inspection for the construction of nuclear installations, the periodic inspection for operating nuclear installations, the quality assurance audit, the daily inspection by resident inspectors, and the special inspection, pursuant to the Atomic Energy Act. The general procedure for each inspection is schematically described in Figure II.2-5.

Pre-operational Inspection for the Construction of Nuclear Installations

The pre-operational inspection for the setup of nuclear installations is conducted to verify whether the nuclear installation is properly constructed in conformity with the conditions of the CP and whether the constructed nuclear installation may be operated safely throughout its lifetime. It is conducted for the construction and the performance of the facilities by means of a document inspection and a field inspection.

Periodic Inspection for Operating Nuclear Installations

The periodic inspection for an operational nuclear installation is conducted to verify whether the nuclear installation is properly operating in conformity with the conditions of the OL; to verify whether the installation can still withstand pressure, radiation and other operating environments; and whether the performance of the installation maintains license based conditions. It is performed by means of a document inspection and a field inspection during the period of refueling outage for a PWR, and during periodic maintenance for a PHWR.

Quality Assurance Audit

The quality assurance audit is conducted to verify whether all activities affecting quality at every stage of the design, construction and operation of a nuclear installation are being performed in conformity with the quality assurance program approved by the regulatory body. It is conducted periodically for operational nuclear installations.

Daily Inspection by Resident Inspectors

The main purpose of the daily inspection is to daily check the nuclear installations under construction or in operation. It includes a field inspection on the surveillance tests, an investigation on the measures taken when the reactor reached an abnormal state, and a verification of the adequacy of the operator's activity regarding the radiation control.

Special Inspection

The special inspection includes an examination of important safety issues, if any, and an in-depth field investigation for the prevention of any potential accident.

II.2.5 Enforcement

In case that the safety review results of the CP application meet the relevant requirements, the Minister of Science and Technology will issue a CP. The Minister may impose minimum conditions therein, if judging that it is necessary to secure safety. If any violation is found as a result of the regulatory inspection, the Minister may order the license holder to take corrective or complementary measures in accordance with the Atomic Energy Act.

If it is deemed necessary for the enforcement of the regulations, the Minister of Science and Technology is authorized to order the operators to submit the necessary documents on their business and to complement any submitted documents. The Minister may also conduct a regulatory inspection to verify that the documents are in conformity with field conditions and order the operator to take corrective or complementary measures, if any, as a result of the inspection.

The Minister of Science and Technology may order the revocation of the permit (or license) or the suspension of business within a period of not more than one year, in cases where the installer or operator of a nuclear installation falls under one of the followings. ***However, if suspension is likely to cause a grave inconvenience to the users, etc. of the project, or to be detrimental to the public interest, surcharges may be imposed instead of suspension of the business.***

- where the installer or operator has modified any matters subject to the permit (or license) without approval,
- where the installer or operator has failed to meet the criteria for permit (or license),
- where the installer or operator has violated an order of the Minister of Science and Technology to take corrective or complementary measures as a result of the regulatory inspections for the construction or operation of a nuclear installation ***and the matters related to measurement control of special nuclear materials*** and
- where the installer or operator has violated any of the permit (or license) conditions or regulations on safety measures in the operation of a nuclear installation.

If a licensee whose permission was revoked or whose business has been discontinued does not take the necessary actions concerning radioactive materials and radiation generating devices, and etc., the MOST can take necessary actions; furthermore, the licensee will be responsible for the payment of cost of such actions.

In addition, if the operator of NPPs violates obligations as prescribed by the Atomic Energy Act, the penal clauses (penalty and fine) may be applied in accordance with the extent of the violation.

Table II.2-1 Laws Concerning Nuclear Regulation (1/2)

Title	Major Contents	Competent Authorities	Remarks
Atomic Energy Act	Integrated law on the development and utilization of nuclear power ***and safety regulations thereof***	Ministry of Science and Technology	-
Korea Institute of Nuclear Safety Act	Provides the establishment and operation of the Korea Institute of Nuclear Safety	Ministry of Science and Technology	-
Act on Physical Protection and Radiological Emergency	Establishes effective physical protection system of nuclear materials and nuclear facilities and provides legal and institutional basis for preventing radiological disaster and preparing countermeasures against radiological emergency	Ministry of Science and Technology	-
Nuclear Liability Act	Provides the procedures and extent of compensation for any damages which an individual has suffered from a nuclear accident	Ministry of Science and Technology	-
Act on Indemnification Agreement for Nuclear Liability	Provides the particulars on a contract between the government and the operator to make up any compensation not covered by insurance	Ministry of Science and Technology	-
Electricity Business Act	Provides the basic system of electricity business	Ministry of Commerce, Industry, and Energy	The Atomic Energy Act is entrusted for the particulars on the safety regulations of the installation, maintenance, repairs, operation and security of nuclear facilities
Electric Source Development Promotion Act	Provides special cases relevant to the development of electric sources	Ministry of Commerce, Industry, and Energy	***Special procedures for the site of NPP***
Framework Act on Environmental Policy	Mother law of the environmental preservation policy	Ministry of Environment	The Atomic Energy Act is entrusted for the particulars on the measures to prevent radiological contamination

Table II.2-1 Laws Concerning Nuclear Regulation (2/2)

Title	Major Contents	Competent Authorities	Remarks
Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc.	Provides the extent and procedures to assess environmental impacts according to the Basic Law of Environmental Policy	Ministry of Environment	Assessment of environmental impacts excluding radiological impacts
Framework Act on Fire Services	Provides the general matters on the prevention, precaution and extinguishment of fire	Ministry of Government Administration and Home Affairs	The requirements for safety management of inflammables
Building Act	Provides the general matters on construction	Ministry of Construction and Transportation	The Atomic Energy Act is entrusted for the particulars on the construction permit for a nuclear installation
Industrial Safety and Health Act	Provides the preservation and enhancement of workers' health and safety	Ministry of Labor	The Atomic Energy Act is entrusted for the particulars on radiological safety
Industrial Accident Compensation Insurance Act	Provides insurance to compensate for workers with industrial disaster	Ministry of Labor	-
Basic Act on Civil Defense	Provides the general matters on the civil defense system	Ministry of Government Administration and Home Affairs	Preparedness against nuclear accidents disaster is included in the basic civil defense plan
Basic Act on Management of Disasters and Safety	Provides the general matters on controls of man-made disasters	Ministry of Government Administration and Home Affairs	It prescribes corrective or complementary measures for violations in the implementation of the basic civil defense plan

Table II.2-2 Contents of the Atomic Energy Act

Title		Major Contents
Chapter 1	General provisions	The purpose of this Act and definitions of the terminology used in this Act
Chapter 2	Atomic Energy Commission and Nuclear Safety Commission	Establishment, functions, and composition of the Atomic Energy Commission and the Nuclear Safety Commission
Chapter 3	Establishment and enforcement of the overall nuclear energy promotion program, research and development, etc. of nuclear energy	Establishment and enforcement of the comprehensive promotion plan for nuclear energy, nuclear energy research and development institution, burden of cost for nuclear energy research and development work, ***Establishment of KINAC***
Chapter 3-2	Nuclear energy research and development fund	Establishment, management and operation of the fund
Chapter 4 Section 1 Section 2 Section 3	Construction and operation of nuclear power reactors and related facilities Construction of nuclear power reactors and related facilities Operation of nuclear power reactors and related facilities Construction and operation of nuclear research reactors, etc.	Criteria for permit (license), licensing procedures, license application documents to be submitted, regulatory inspection, records and keeping, appointment (dismissal) and obligation of responsible persons for nuclear reactor operation, notification of suspension or disuse of operation, transfer and inheritance, measure for suspension, decommissioning and penalty surcharge
Chapter 5	Deleted	
Chapter 6 Section 1 Section 2	Nuclear fuel cycle enterprise and use, etc. of nuclear materials Nuclear fuel cycle enterprise Use of nuclear materials	Criteria for permit (license), licensing procedures, license application documents to be submitted, and regulatory inspection
Chapter 7	Radioisotopes and radiation generating devices	Criteria for permit (license), licensing procedures, and regulatory inspection
Chapter 7-2	Deleted	
Chapter 8	Disposal and transport	Permit for construction and operation of disposal facilities, and regulatory inspections
Chapter 9	Personnel dosimetry service	Registration of personnel dosimetry service and regulatory inspection
Chapter 10	License and examination	License examination and certificate of license
Chapter 11	Regulation and supervision	Establishment of exclusion area and preventive measures against radiation hazards
Chapter 12	Supplementary provisions	Conditions for permit or designation, approval of report on specific technical subjects, hearing, protection for the individual in charge of safety management, education and training
Chapter 13	Penal provisions	Penal provisions, fine for negligence, and joint penal provisions
Addenda		Enforcement date, transitional measures, and relations with other laws

Table II.2-3 Notices of the Minister of Science and Technology Applicable to Nuclear Installations

Number	Title	Effective Date
2001-46	Standard Format and Content of Technical Specifications for Operation	27/12/01
2000-08	Technical Standards for Locations, Structures and Equipment of Nuclear Reactor Facilities	23/06/00
2005-19	***Standard Format and Content of Radiation Environmental Report for Nuclear Power Utilization Facilities***	***10/06/05***
2004-17	***Regulation on Survey of Radiation Environment and Assessment of Radiological Impact on Environment in Vicinity of Nuclear Power Utilization Facilities***	***13/07/04***
2005-08	***Regulation on Other Facilities related to Safety of Nuclear Reactor***	***18/05/05***
2001-43	Regulation on Disposition and Control of Inspection Findings of Nuclear Power Utilization Facilities	01/12/01
2005-03	***Material Surveillance Criteria for Reactor Pressure Vessel***	***22/03/05***
2002-21	Regulation on Safety Classification and Applicable Codes and Standards for Nuclear Reactor Facilities	26/12/02
2004-13	***Regulation on In-Service Inspection of Nuclear Reactor Facilities***	***02/07/04***
2005-07	***Regulation on Reporting and Public Announcement of Accidents and Incidents for Nuclear Power Utilization Facilities***	***02/05/05***
2005-25	***Pressure Test Criteria for Major Components of Nuclear Reactor Facilities***	***26/09/05***
2005-04	***Guidelines for Application of Korea Electric Power Industry Code (KEPIC) as Technical Standards of Nuclear Reactor Facilities***	***22/03/05***
2001-38	Standards for Safety Valves and Relief Valves of Nuclear Reactor Facilities	01/12/01
2001-39	Standards for Performance of Emergency Core Cooling System of Pressurized Light Water Reactor	01/12/01
2004-15	***Standards for Leakage Rate Tests of Reactor Containment***	***02/07/04***
2001-47	Detailed Requirements for Quality Assurance of Nuclear Reactor Facilities	27/12/01
2005-09	***Regulation on Pre-operational Inspection of Nuclear Reactor Facilities***	***18/05/05***
2002-05	Regulation on Schedule for First Periodic Safety Review of Nuclear Power Reactor Facilities	04/01/02
2003-11	Technical Standards for Investigation and Evaluation of Meteorological Conditions of Nuclear Reactor Facility Sites	24/07/03
2003-12	Technical Standards for Investigation and Evaluation of Hydrological and Oceanographic Characteristics of Nuclear Reactor Facility Sites	24/07/03
2003-19	Regulation on Establishment and Implementation of Fire Protection Program	17/11/03
2003-20	Technical Standards for Fire Hazard Analysis	17/11/03
2004-14	***Regulation on In-Service Test of Safety-related Pumps and Valves****	***02/07/04***
2005-10	***Regulation on Items and Method of Periodic Inspection for Nuclear Reactor Facilities****	***18/05/05***
2005-31	***Guidelines on Application of Technical Standards for Assessment of Continued Operation of Nuclear Reactor Facilities beyond Design Life****	***01/12/05***
2006-05	***Objects of Consultations due to Installation of Industrial Facilities around the Nuclear Reactor Facilities, etc.****	***29/03/06***
2002-23	Standards for Radiation Protection, etc.	06/01/03
2004-11	***Standards for Preparation of Radiological Emergency Plan of a Nuclear Licensee***	***25/06/04***
2002-14	Regulation on the Contents and Calculation Method of Work Career for Implementation of Nuclear Power-related Examination for License	17/10/02
2006-26	***Regulation on Education and Training for Radiation Safety Control, etc.***	***20/10/06***
2001-41	Regulation on Refresher Education for the Holder of a License for the Supervisor of Nuclear Reactor Operation and 0f a License for the Operator of Nuclear Reactor	01/12/01
2006-28	***Regulation on Radiological Emergency Training****	***10/11/06***

**** Established during 2004 ~ 2006***

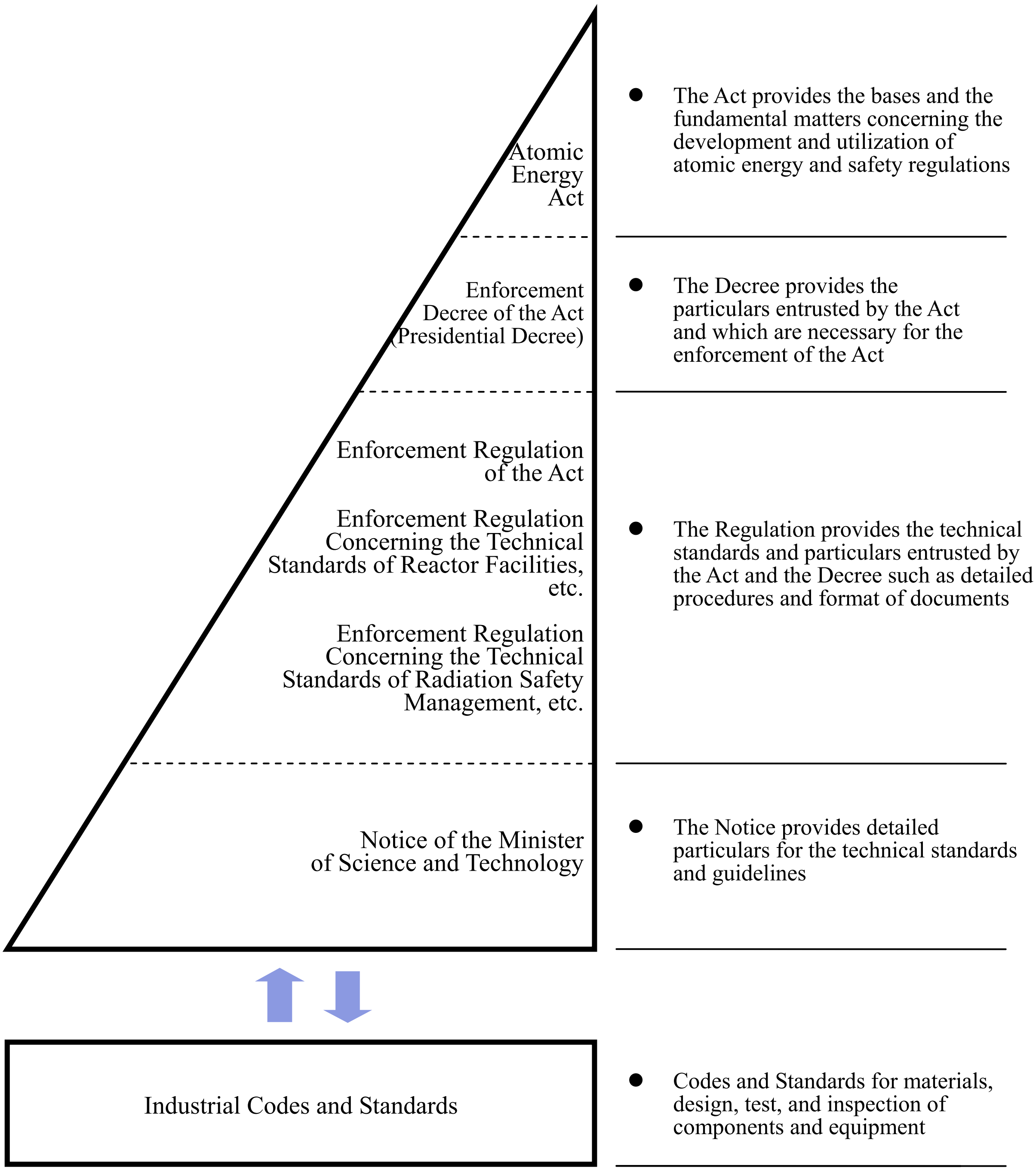


Figure II.2-1 Atomic Energy Act System

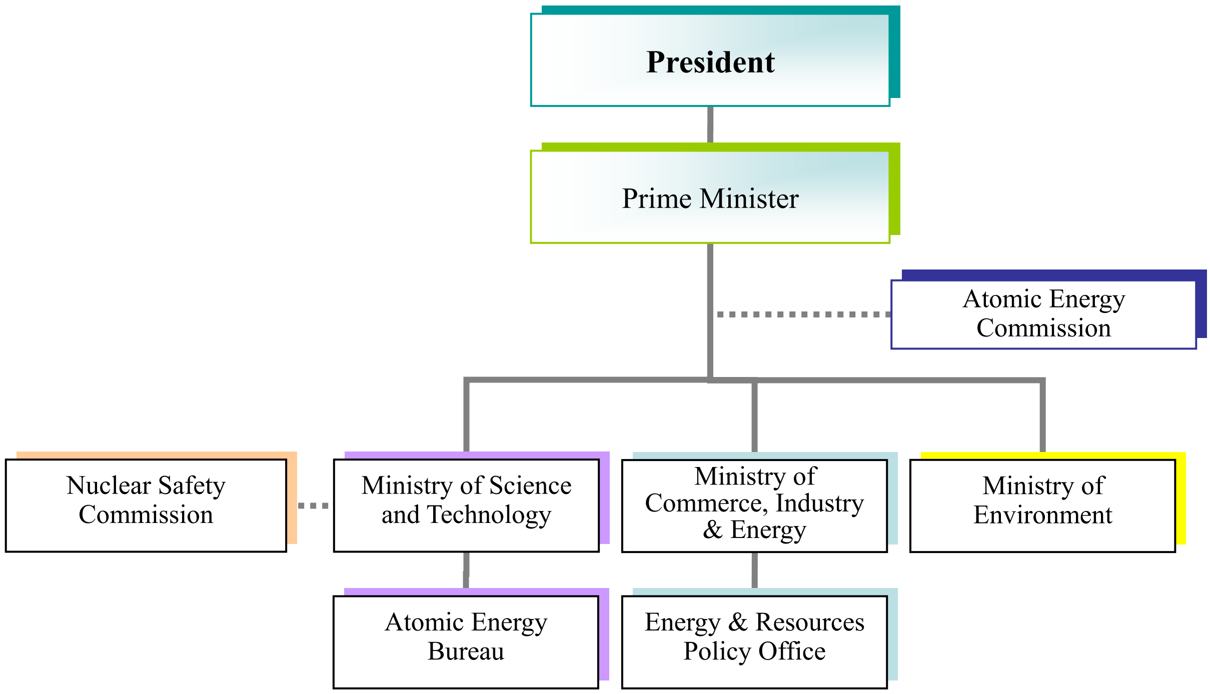


Figure II.2-2 Governmental Organizations Related to Nuclear Energy

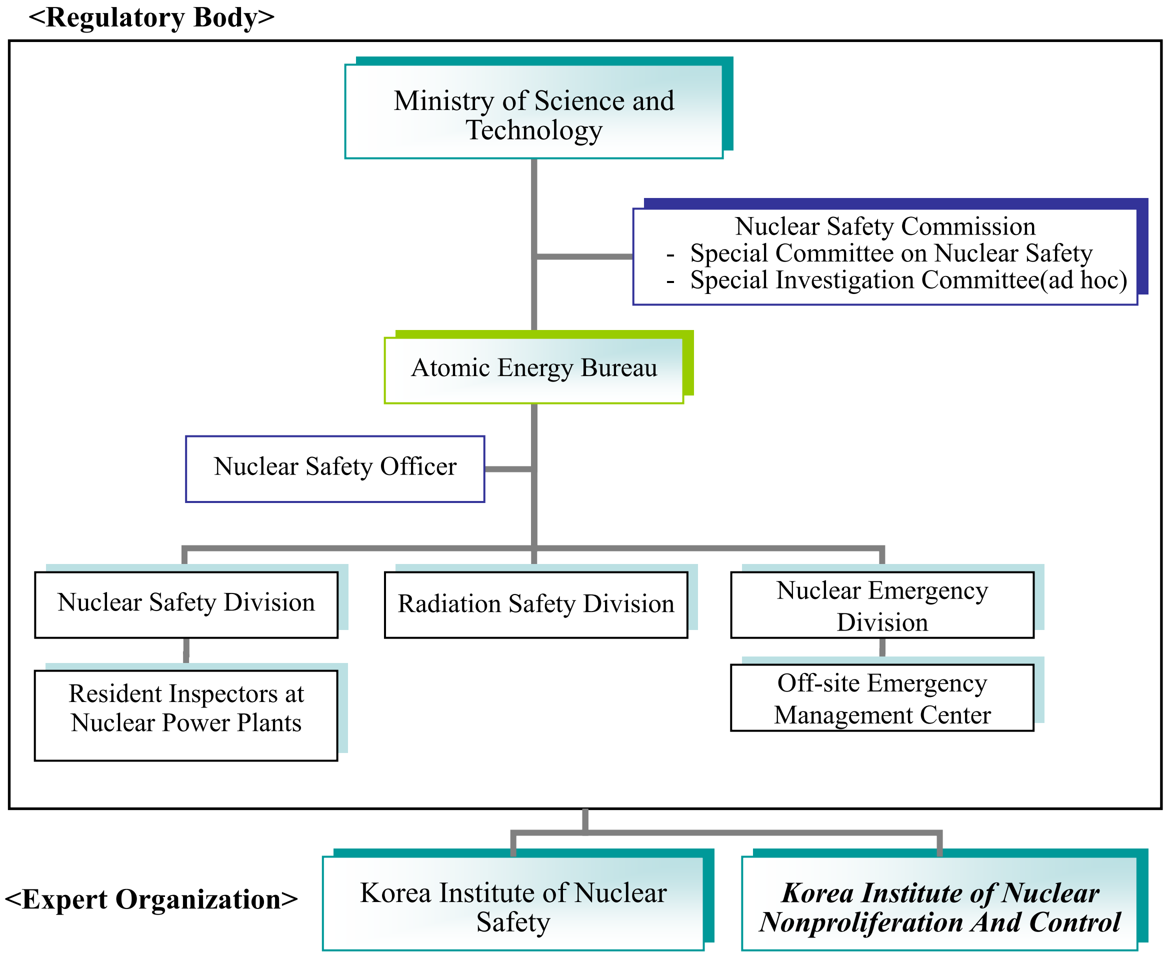


Figure II.2-3 Nuclear Safety Regulatory System

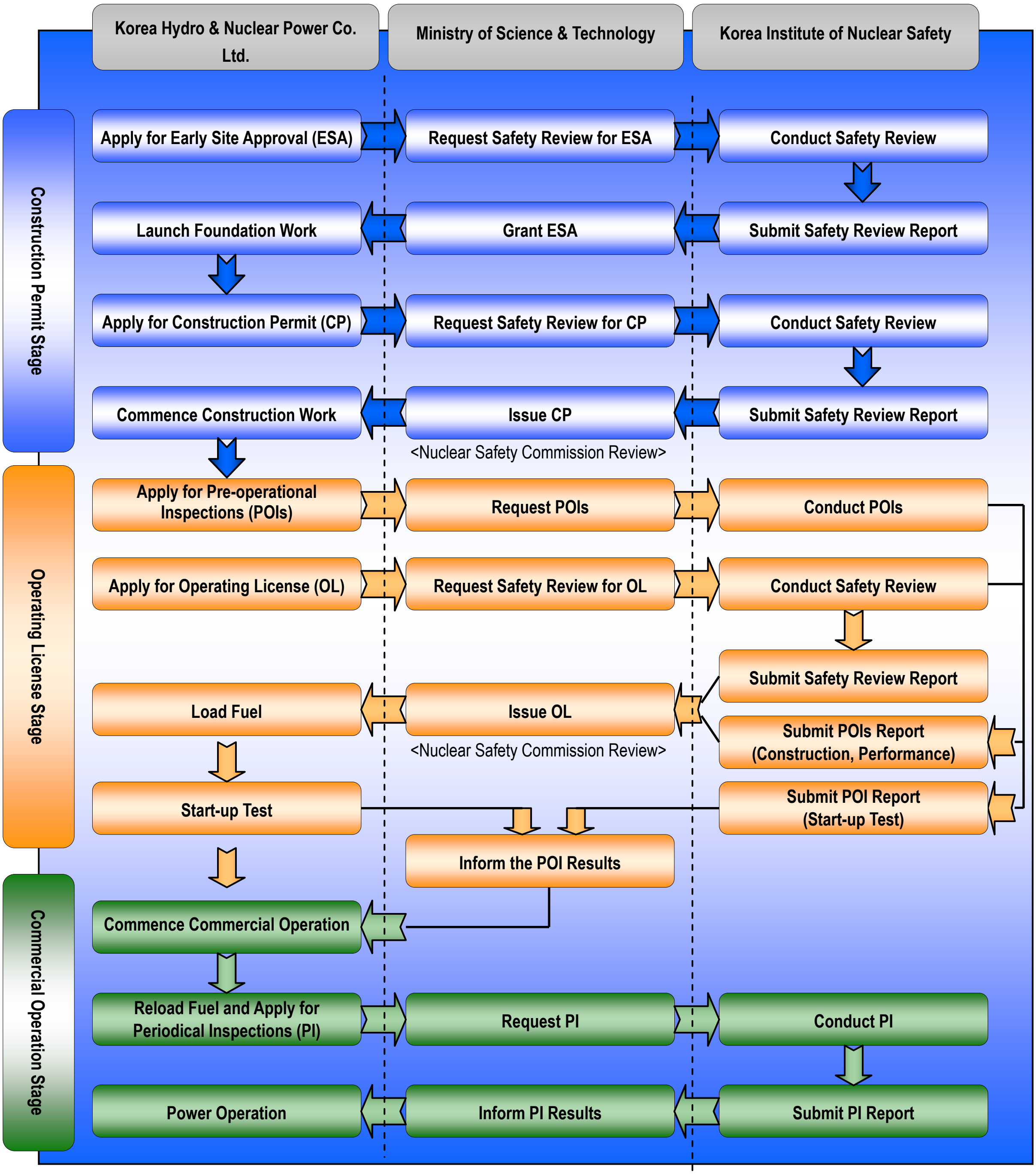


Figure II.2-4. Licensing Process for Nuclear Installations

Figure II.2-5 Regulatory Inspection Process for Nuclear Installations

II.3 Regulatory Body (Article 8)

II.3.1 Mandates and Duties of Regulatory Body

The primary mission of the MOST is to ensure adequate protection of the public health and the environment against radiation hazards that may accompany the peaceful use of nuclear energy. It includes the following major functions:

- to establish policies for nuclear safety and regulation,
- to review and assess safety information of nuclear installations,
- to issue, amend or revoke licenses for the construction and operation of nuclear installations,
- to conduct regulatory inspections,
- to establish technical standards and regulatory requirements,
- to take necessary enforcement actions, where a violation of regulatory requirements has taken place,
- to ensure that corrective actions are taken where unsafe or potentially unsafe conditions are detected,
- to ensure the appropriate emergency response capabilities,
- to ensure that the records of occupational radiation exposure are maintained,
- to assure the qualifications of radiation workers,
- to provide nuclear safety information for the public, and strengthen international cooperation for the enhancement of the public confidence.

The Ministry is responsible to perform the following additional functions:

- to operate the national environmental radiation monitoring program and
- to initiate and coordinate nuclear safety research and development.

II.3.2 Authority and Responsibility of Regulatory Body

The authority of the MOST, which is prescribed in the Atomic Energy Act and the Enforcement Decree of the National Government Organization Act, is as follows:

- to issue, amend and revoke licenses for the construction and operation of nuclear installations, and to take the necessary enforcement actions, where a violation of regulatory requirements has taken place,
- to conclude agreements with other domestic governmental or non-governmental bodies and to delegate tasks to other organizations, where such delegation is directly essential to the performance of the body's regulatory responsibilities,
- to obtain such documents and opinions from public or private organizations or persons as may be both necessary and appropriate,
- to maintain contact with foreign regulatory bodies and relevant international organizations, and
- to enter, at any time, the premises of any nuclear installation licensed or under review.

The MOST assumes the responsibility to develop the acceptance criteria for constructing and operating nuclear installation, to develop technical standards for operational safety measures, and to ensure compliance at every stage of the siting, design, construction, commissioning, operation, and decommissioning of nuclear installations.

II.3.3 Structure and Resources of Regulatory Body and Supporting Organizations

Ministry of Science and Technology (MOST)

As shown in Figure II.3-1, the NSC, under the jurisdiction of the Minister of Science and Technology, is responsible for deliberating and making decision on important matters concerning nuclear safety. The Vice Minister and the Director General in charge of the Atomic Energy Bureau are on a vertical organization under the Minister.

The Atomic Energy Bureau consists ***of 5 divisions and 1 team;*** the ***Atomic Energy*** Policy Division, the Atomic Energy Cooperation Division, the Nuclear Safety Division, the Radiation Safety Division, the Nuclear Emergency Division ***and the Nuclear Control Team.*** In the Atomic Energy Bureau, a nuclear safety officer assists and advises the Director General of the Bureau in the matter of nuclear safety regulation, radiation safety management and nuclear emergency management. The staff participating in nuclear activities totals ***66,*** of which ***40*** persons are responsible for safety regulation. The functions of 3 divisions in charge of the safety regulation of nuclear installations are as follows:

- Nuclear Safety Division
  - to establish the basic policy on nuclear safety
  - to coordinate and control the activities of nuclear safety regulation
  - to support the Nuclear Safety Commission
  - to establish and apply the technical standards of nuclear safety
  - to issue permits for facilities related to reactor and nuclear fuel cycle facilities
  - to support and foster regulatory expert organization
  - to issue Standard Design Approval of nuclear power plants
  - to promote and enhance nuclear safety culture
  - to issue and control the licenses for reactor operators and senior reactor operators
  - to carry out inspections for the quality and performance of materials and equipments, etc. in the construction of reactor and nuclear related facilities
  - to carry out the inspections relevant to the operation of reactors and the supervision of facility security
  - to study and develop the systems pertaining the quality assurance of nuclear reactors, nuclear-related facilities including materials and equipments
  - to superintend the resident inspectors of nuclear installations
  - to carry out administrative activities on the Convention on Nuclear Safety

- Radiation Safety Division
  - to carry out inspections for the quality and performance of materials and equipments, etc. in the construction of the facilities related to nuclear materials
  - to carry out inspections for operation of facilities related to nuclear materials and the supervision for its physical protection
  - to establish and coordinate measures for radiation protection
  - to carry out regulatory mission for closure and decommissioning of nuclear facilities
  - to license and supervise the production and use of nuclear materials, radioisotopes and radiation generating devices
  - to establish and coordinate protective measures against radiation sources
  - to control the licenses of supervisors of radioisotope and nuclear materials
  - to carry out exposure control of radiation workers

- to issue design approval and carry out inspection for radiation equipments and transport container of radioactive materials
- to certify and supervise agents for handling and controlling radioisotopes
- to formulate and apply technical standards for radiation safety
- to supervise education for radiation workers, frequent access personnel
- to license and supervise construction and operation of radioactive waste disposal facilities

● Nuclear Emergency Division
- to formulate and coordinate radiation protection measures
- to manage and evaluate radiological emergency exercises
- to direct and supervise the evaluation of radiological environmental impact around nuclear installations
- to monitor and evaluate the national environmental radiation
- to operate the central nuclear emergency management center
- to establish and operate the monitoring system of safe operation of nuclear power plant
- to control and supervise KINS Radiological Emergency Center
- to coordinate PSA of nuclear power plant
- to coordinate the nuclear damages reparation and its compensation contract
- to support system establishment of the national medical examination and treatment in case of a radiological emergency
- to control and coordinate education and training of radiological emergency staffs
- to perform overall management of radiological hazards

● Resident Inspectors ***at Nuclear Installation Sites***
- daily inspection and reporting status of constructing and operational nuclear power plants to head office
- witness of inspections performed by utility on reactor and nuclear material-related facilities
- confirmation of safety control activities at site and corrective action
- supporting KINS inspection activities at site

● Off-site Emergency Management Center
- acquisition and notification of information as well as prompt control and management of a radiological emergency

- co-ordination of off-site emergency response activities
- Function of integrated information center
- co-ordination with Emergency Operations Headquarter of the utility

MOST performs various regulatory co-operations for nuclear safety through the agreements between Korea and foreign countries (Table II.3-1). KINS concludes, under the bilateral agreement, Memorandum of Understanding (MOU) with regulatory expert agencies of foreign countries, and performs also various co-operation for Exchange of Technical Information and Cooperation in Safety Matters (Table II.3-2).

Nuclear Safety Commission (NSC)

The NSC is established under the jurisdiction of the Minister of Science and Technology in order to deliberate and decide on important matters concerning nuclear safety, pursuant to the Atomic Energy Act. The Commission deliberates and decides on the following matters:

- consolidation and coordination of matters concerning nuclear safety control,
- matters concerning the regulation of nuclear materials and reactors,
- matters concerning the protection against hazards due to radiation exposure,
- matters concerning the plan for estimation and allocation of expenditures for nuclear safety control,
- matters concerning the formulation of tests and research for nuclear safety control,
- matters concerning the fostering and training of researchers and engineers in the area of nuclear safety control,
- matters concerning the safety management of radioactive waste,
- matters concerning the measures against radiation accidents, and
- other matters deemed important by the chairman.

The NSC, which is chaired by the Minister of Science and Technology, ***consists of 8 members including 7 who were*** appointed or commissioned by the Minister (Table II.3-3). Any person engaged in the operation of nuclear installations shall not be commissioned to be a member of the Commission ***in order to reinforce the independence of the nuclear safety regulation activities***.

The Commission organizes the Special Committee on Nuclear Safety to technically investigate and deliberate matters under its jurisdiction. This Committee is composed of 25 experts or less, and for its effective operation, ***a*** total of 5 Sub-committees are presently operated including a newly established Nuclear Emergency and Radiation Environment Sub-committee in 2002: the Reactor System Sub-committee, the Radiation Protection Sub-committee, the Site and Structure Sub-committee, the Regulatory Policy Sub-committee and the Nuclear Emergency and Radiation Environment Sub-committee. The NSC may also organize and operate the Special Investigation Committee if any nuclear and/or radiation accidents occur.

Korea Institute of Nuclear Safety (KINS)

KINS was established in December 1981 and initially operated under the name of "Nuclear Safety Center" as an internal organization of KAERI. It started functioning as an independent expert organization in February 1990, according to the "Korea Institute of Nuclear Safety Act", and conducts matters on nuclear safety regulation as entrusted by MOST in accordance with the Atomic Energy Laws. Its major functions relevant to nuclear safety regulation are as follows:

- to conduct safety reviews in relation to the licensing and approval of nuclear installations,
- to conduct regulatory inspections during manufacturing, construction and operation of nuclear installations,
- to perform research and development of the technical standards of safety regulation for nuclear installations,
- to conduct license examinations for the handling of nuclear materials and radioisotopes, and the operation of nuclear installations,
- to receive and process notifications relevant to licensing formalities and
- to conduct quality assurance examination and inspection.

KINS also takes responsibility of various activities such as the development of nuclear safety regulation technology, technical support to MOST for policy development and radiation protection, information management on safety regulation, and the monitoring and evaluation of environmental radioactivity.

KINS consists of 6 divisions, 2 groups, and 32 departments and teams as shown in Figure II.3-2 in order to promote the effectiveness and professionalism of regulatory activities.

KINS operates the Advisory Committee on Nuclear Safety, a consultative body for technical matters on safety regulations, which is composed of experts from KINS and various other organizations. ***As of December 2006, KINS consists of 378 staff members, of which 323 persons are technical experts***. The budget is covered by special assessment borne by relevant utilities and government subsidies in accordance with the Atomic Energy Act.

Korea Atomic Energy Research Institute (KAERI)

The Nuclear Training Center, under the control of KAERI and as entrusted by MOST according to the Atomic Energy Laws, performs the retraining of persons designated to take responsibility for handling nuclear fuel materials and radiation safety control. KAERI concluded the cooperation arrangement with KINS for nuclear safety research in September 2002.

Korea Radioisotope Association (KRIA)

KRIA, as entrusted by MOST according to the Atomic Energy Laws, is responsible for maintaining the national registry of occupational radiation exposures and retraining of radiation workers.

Korea Institute of Nuclear Nonproliferation And Control (KINAC)

Korea Institute of Nuclear Nonproliferation and Control was established in June 2006, as commissioned by the MOST, to perform the task of safeguards, control of export and import of nuclear materials, physical protection, and research and development concerning nuclear facilities and nuclear materials.

II.3.4 Position of Regulatory Body in Governmental Structure

MOST, the nuclear safety regulatory body, has complete authority and responsibility for the safety regulations, including the issuance of permits and licenses for nuclear installations and it is free from the intervention of other Ministries in the area of safety regulation. The Minister who joins the AEC as an ex officio member is involved in making decisions on major national policies related to the development and utilization of nuclear energy.

II.3.5 Relationship of Regulatory Body to Organizations Responsible for Promotion and Utilization of Nuclear Energy

MOCIE is responsible for the promotion and utilization of nuclear energy and for formulating and implementing the Basic Electricity Supply Plan. MOST performs the regulatory functions for the construction and operation of nuclear installations, thus maintaining a separation of safety regulations from MOCIE. MOST also operates the NSC, an independent deliberative organization, to enhance the objectivity and impartiality in safety regulations.

Table II.3-1 The Bilateral Agreements between Korea and Foreign Countries for Nuclear Cooperation

Country	***Name of cooperation Agreement***	***Signatory Date***	***Effective Date***
UNITED STATES	Amendment to Agreement for Cooperation between the Government of the Republic of Korea and the Government of the United States of America concerning Civil Uses of Atomic Energy	1972.11.24 Revision 1974. 5.15	1973. 3.19 Revision 1974. 6.16
CANADA	Agreement between the Government of the Republic of Korea and the Government of Canada for Cooperation in the Development and Application of Atomic Energy for Peaceful Purposes	1976. 1.26	1976. 1.26
SPAIN	Supplemental Agreement between the Atomic Energy Commission of the Republic of Korea and the Atomic Energy Commission of Spain for Co-operation in the Peaceful Uses of Nuclear Energy	1975. 7.14	1976.12.10
AUSTRALIA	Agreement between the Government of the Republic of Korea and the Government of Australia concerning Cooperation in Peaceful Uses of Nuclear Energy and the Transfer of Nuclear Material	1979. 5. 2	1979. 5. 2
BELGIUM	Agreement between the Government of the Republic of Korea and the Government of Belgium concerning the Collaboration in the field of the Pacific Utilization of Nuclear Energy	1981. 3. 3	1981. 3. 3
FRANCE	Agreement between the Government of the Republic of Korea and the Government of the French Republic relating to Peaceful Utilization of Atomic Energy	1981. 4. 4.	1981. 4. 4
GERMANY	Agreement between the Government of the Republic of Korea and the Government of the Federal Republic of Germany for Cooperation in the Peaceful Uses of Nuclear Energy	1986. 4.11	1986. 4.11
JAPAN	Exchange of Notes between the Government of the Republic of Korea and the Government of Japan concerning Cooperation in Nuclear Energy	1990. 5.25	1990. 5.25
UNITED KINGDOM	Agreement between the Government of the Republic of Korea and the Government of the United Kingdom of Great Britain and Northern Ireland for Co-operation in the Peaceful Uses of Nuclear Energy	1991.11.27	1991.11.27
CHINA	Agreement between the Government of the Republic of Korea and the Government of the People's Republic of China for Cooperation in the Peaceful Uses of Nuclear Energy	1994.10.31	1995. 2.11
ARGENTINA	Agreement between the Government of the Republic of Korea and the Government of the Argentine Republic for Cooperation in the Peaceful Uses of Nuclear Energy	1996. 9. 9	1997. 9.19
VIETNAM	Agreement between the Government of the Republic of Korea and the Government of the Socialist Republic of Vietnam for Cooperation in Research into the Peaceful Uses of Nuclear Energy	1996.11.20	1997. 1. 6
TURKEY	Agreement between the Government of the Republic of Korea and the Government of the Republic of Turkey for Cooperation in the Peaceful Uses of Nuclear Energy	1998.10.26	1999. 6. 4
RUSSIA	Agreement between the Government of the Republic of Korea and the Government of the Russian Federation on for Cooperation in the Peaceful Uses of Nuclear Energy	1999. 5.28	1999.10. 8
BRAZIL	***Agreement between the Government of the Republic of Korea and the Government of Brazil for Cooperation in the Peaceful Uses of Nuclear Energy***	***2001. 1.18***	***2005. 7. 25***
UKRAINE	Agreement between the Ministry of Science and Technology of the Republic of Korea and the Ukrainian State Nuclear Regulatory Committee of Ukraine for the Exchange of Technical Information and Cooperation in Nuclear Safety and Regulatory Matters	2001. 7. 23	-
CZECH	Agreement Between the Government of the Republic of Korea and the Government of the Czech Republic for Cooperation in the Peaceful Uses of Nuclear Energy	2001. 3. 16	2001.6.1
EGYPT	***Agreement between the Government of the Republic of Korea and the***	***2001. 8. 4***	***2002. 6. 24***

	Government of Egypt for Cooperation in the Peaceful Uses of Nuclear Energy		
CHILE	***Agreement between the Government of the Republic of Korea and the Government of Chile for Cooperation in the Peaceful Uses of Nuclear Energy***	***2002. 11. 12***	***2006. 9. 3***
ROMANIA	***Agreement between the Government of the Republic of Korea and the Government of Romania for Cooperation in the Peaceful Uses of Nuclear Energy in Industry as well as Research and Development Sectors***	***2004.2.3***	***2004. 9. 6***
KAZAKHS TAN	***Agreement between the Government of the Republic of Korea and the Government of the Republic of Kazakhstan for Cooperation in the Peaceful Uses of Nuclear Energy***	***2004. 9. 20***	

Table II.3-2. The Status of International Cooperation of KINS for Nuclear Safety

Country (Institution)		***Type of Cooperation***	***Conclusion Date***
Korean Peninsula Energy Development Organization (KEDO)		Cooperation Agreement	1999. 6.16
United States : Brookhaven National Lab. (BNL)		MOU	1995. 8.14
France : Institute of Radiation Protection & Nuclear Safety (IRSN)		Cooperation Agreement	1990. 9.24 Revision 2001.4.10
United Kingdom : National Radiological Protection Board (NRPB)		MOU	2001.11.30
Germany : Gesellschaft for Anlagen und Reaktorsicherheit mbH (GRS)		Arrangement	1998. 9.25
Japan	Japan Nuclear Energy Safety Organization (JNES)	MOU	2004. 3. 8
Japan	Japan Chemical Analysis Center (JCAC)	MOU	1989. 3. 3 Revision 1991.7.9
China	National Nuclear Safety Administration (NNSA)	Arrangement	1996. 4.17 Revision 2000.12.4
China	Radiation Monitoring Technical Centre (RMTC)	MOU	2002.12. 4
China	China Institute for Radiation Protection (CIRP)	Arrangement	1995. 6.19
Romania : National Commission for Nuclear Activities Control (CNCAN)		MOU	1996. 9.21
		Additional agreement	***2006.12. 01***
Sweden ***Swedish Radiation Protection Authority***		***MOU***	***2004.9.21***

Finland ***STUK (Radiation and Nuclear Safety Authority)***		***Agreement***	***2006.09.08***
Indonesia ***(Nuclear Energy Regulatory Agency-BAPETEN)***		***Agreement***	***2006.11.20***
Vietnam	***VARANSAC (Vietnam Agency for Radiation and Nuclear Safety and Control)***	***MOU***	***2007.1.29***
	University of Dalat	***MOU***	***2007.1.31***

Table II.3-3 Members of the Nuclear Safety Commission

(Term of office: 2006. 8 – 2009. 8)

Name	***Title***	***Name***	***Title***
Goon-Cherl Park	***Professor, Nuclear Engineering Department, Seoul National University***	***Sun Young Park***	***Professor, Law Department, Catholic University***
Poong Hyun Seong	***Professor, Nuclear and Quantum Engineering Department, KAIST***	***Eun Kyung Choi***	***Head, Radiation-Oncology Department, Asan Medical Center***
Seong Woon Hong	***Vice-President, Shinil Hospital***	***Won-Ky Shin***	***President, Korea Institute of Nuclear Safety***
Wook Han	***Professor, Civil Engineering and Environment Science Department, Korea Military Academy***		

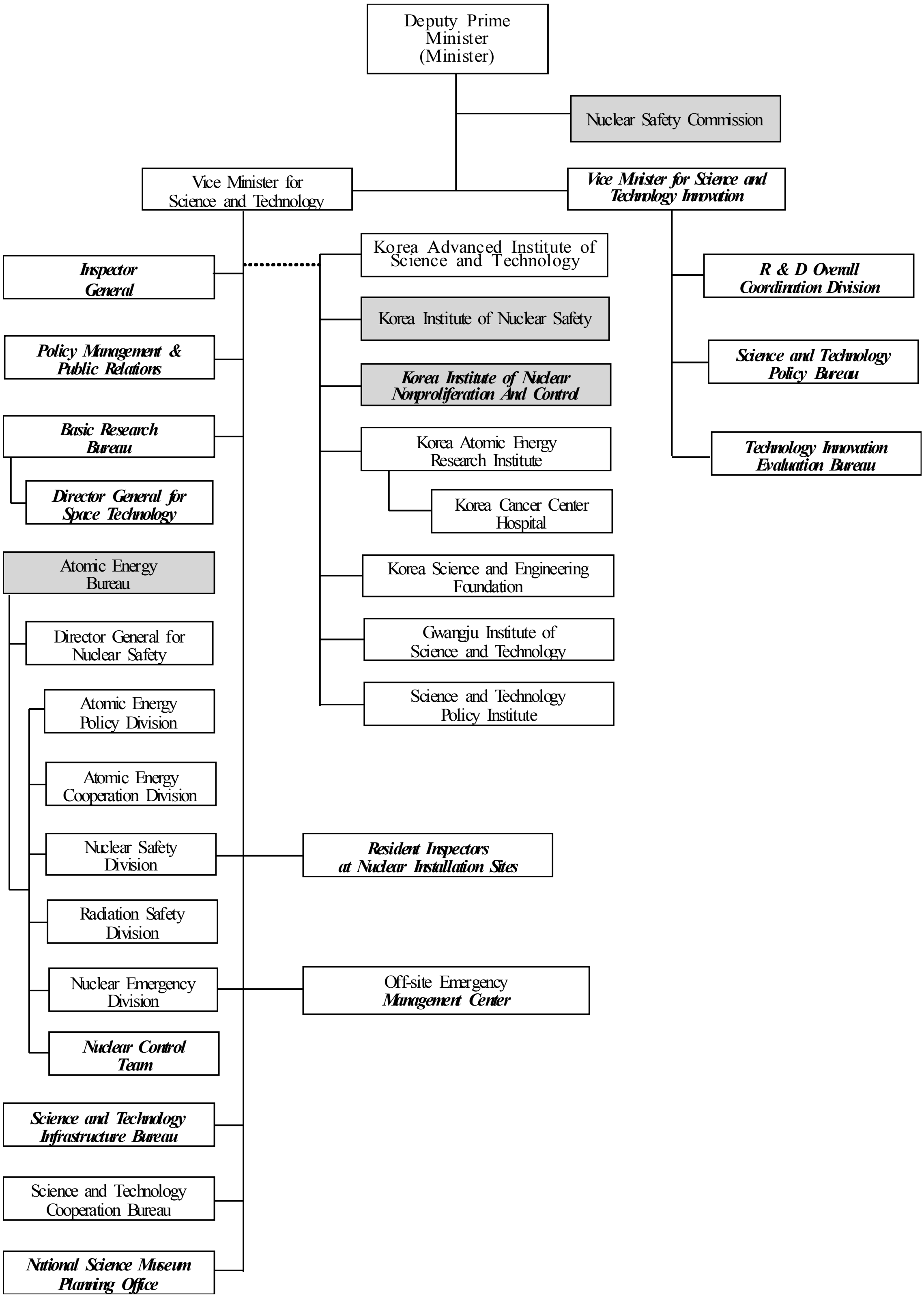


Figure II.3-1 Organization Chart for the Ministry of Science and Technology

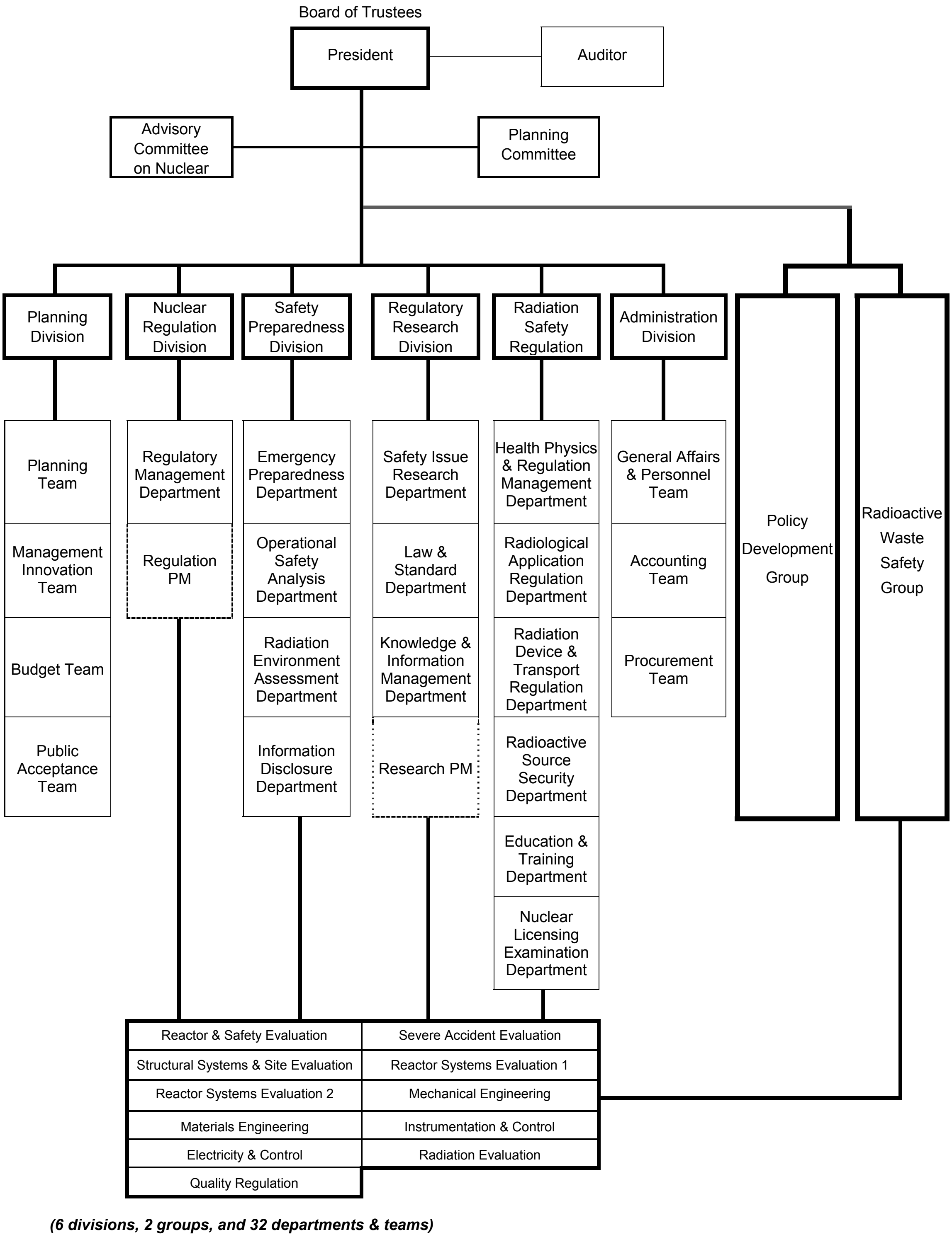


Figure II.3-2 Organization Chart for the Korea Institute of Nuclear Safety

II.4 Responsibility of License Holder (Article 9)

II.4.1 Responsibility of License Holder

The holder of a CP assumes the responsibility to construct a nuclear installation as approved at the time when the CP was issued. The holder also assumes the responsibility to comply with the conditions imposed on the CP by the regulatory body.

The holder of an OL assumes the responsibility to operate a nuclear installation as approved at the time when the OL was issued. The holder also assumes the responsibility to comply with the conditions imposed on the OL by the regulatory body.

According to the "Nuclear Safety Policy Statement", the ultimate responsibility for the safety of a nuclear installation rests with the operating organization and is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors and regulators.

II.4.2 Mechanism for Fulfillment of License Holder's Responsibility for Safety

The Minister of Science and Technology, in accordance with the Atomic Energy Act, assumes the responsibility to verify by means of regulatory inspections described in Section II.2.4, that the installer or operator of nuclear installations comply with the permit or license conditions during construction or throughout the lifetime of the installations. If a violation takes place, the said Minister immediately orders the installer or operator to take corrective and complementary measures so as to secure the safety of the nuclear installation.

The installer of a nuclear installation shall undergo pre-operational inspections from MOST to verify that the nuclear installation is constructed as previously approved. After passing the inspections, the installer can commence operation. The operator of a nuclear installation shall undergo periodic inspections from the Minister of Science and Technology to assure that the performance of the nuclear installation maintains conformity with the technical standards as prescribed in the relevant provisions, and that other performances including the resistance to pressure and radiation maintain the same state as they were when passing the pre-operational inspection.

If the installer or operator of a nuclear installation has failed to meet the permit or license conditions, the Minister of Science and Technology may order the revocation of the permit or license or the suspension of the business for a given period. If the performance of the nuclear installation does not meet the standards or if safety measures for the operation of the nuclear installation are unsatisfactory, the Minister may order the operator to take corrective actions or to suspend the operation of the nuclear installation.

C. General Safety Considerations

II.5 Priority to Safety (Article 10)

II.5.1 Safety Policy

As mentioned in Section Ⅰ.1.2, the Minister of Science and Technology declares in the "Statement of Nuclear Safety Policy" that the major premise is to secure safety in the utilization and development of nuclear energy, and all organizations and people engaged in nuclear activities have to thoroughly adhere to the principle of "priority to safety".

In the "Comprehensive Promotion Plan for Nuclear Energy" established in accordance with the Atomic Energy Act, MOST again emphasizes that securing safety is prerequisite to the development and utilization of nuclear energy, as a basic direction of nuclear energy policy, and that the best efforts for enhancing nuclear safety must be made.

The nuclear safety policy manifests the Government's intention to make the utmost efforts for the prevention and mitigation of nuclear accidents. The consequences of nuclear accidents are intensified because of the geographical and demographical characteristics of Korea, such as small land areas and a high population density.

II.5.2 Safety Culture and its Development

In the "Nuclear Safety Policy Statement", the Minister of Science and Technology has proposed, as a basic principle, to develop the safety culture presented by IAEA, recognizing that human factors are just as important as technical factors are in contributing to the safety of nuclear installations, through lessons learned from the accidents of TMI and Chernobyl nuclear power plants.

The Minister of Science and Technology established, in the Comprehensive Promotion Plan for Nuclear Energy, a program by organizations to promote safety culture and formulated a basic plan to develop and apply the criteria for evaluating safety culture.

II.5.3 Commitment to Safety

Declaration of Nuclear Safety Charter

The Korean Government declared 'Nuclear Safety Charter' in the occasion of 7th Nuclear Safety Day in September 6, 2001 through the deliberation of the NSC to confirm that nuclear safety has first and foremost priority over promotion of nuclear industry, to encourage the workers in nuclear field to have a sense of mission and responsibility for assuring nuclear safety, and also to contribute to public confidence in nuclear safety. The Charter is attached in Annex C.

II.5.4 Regulatory Control

MOST recognizes that the complete understanding of safety culture is more important than anything else for securing nuclear safety. Therefore, KINS has developed indicators for the safety culture evaluation based on the IAEA Guidelines. MOST encouraged the licensees to perform self-assessment of their safety culture, while KINS, reaching the 10th anniversary of its foundation, made public "the Mission Statement" and "Code of Conduct" in February 2000 as a part of efforts to establish safety culture in regulatory organizations, and exerts its utmost to promote the nuclear utility's activities for nuclear safety culture and settle it in Korea.

II.5.5 Voluntary Activities and Good Practices Related to Safety

Campaigns for nuclear safety

In 1994, the Government designated the 10th of September as the "Nuclear Safety Day". Various events emphasizing nuclear safety have been held by the governmental initiative for the purpose of having workers engaged in all nuclear-related organizations recognize the importance of nuclear safety and solidify their commitment to nuclear safety. Among those events, there are technical seminars on nuclear safety and public relation activities for the people. The Government also awards appropriate prizes to organizations and individuals having any distinguished achievement for securing safety. This is done to encourage relevant organizations and employees to recognize the importance of nuclear safety and to further contribute toward nuclear safety.

MOST and other seven major relevant organizations designated the first Tuesday of every month as "Nuclear Safety Alert Day" to awaken mission and responsibility for nuclear safety among employees in their working places. Safety related activities such as safety checkup of equipments has been conducted and safety seminars and symposium have been held in the organizations to observe the "Nuclear Safety Alert Day" since March 2003.

MOST, in collaboration with ***KINS***, introduced "Nuclear Safety Mark" in the fourth quarter 2002 to award the companies, organizations, products and technologies that significantly contributed to the enhancement of nuclear safety to encourage the employees involved in safety related works. Up to December 200***6***, a total of ***33*** organizations, products and technologies have been awarded during ***11*** quarters elapsed.

Details on "Nuclear Safety Day", "Nuclear Safety Alert Day" and "Nuclear Safety Mark are described in Annex E.

Evaluations on the Safety Culture of Employees

The KHNP performed research on the improvement of the safety culture from July 2004 to August 2005 in order to raise safety consciousness of the employees, continue to promote the safety culture and develop safety culture performance indicators. Furthermore, the KHNP has been continuously evaluating safety mind of employees in all their nuclear power plants with the developed safety culture performance indicators. The results of the evaluations are reflected into operational management and training programs for both new and current employees.

Nuclear Safety Technology Information Meeting

The Nuclear Safety Technology Information Meeting is annually held under the auspices of KINS to share up-to-date information on nuclear safety and regulations between regulatory organizations and industries. Emphasis is laid on the greater mutual recognition of the importance of nuclear safety through discussions on nuclear safety issues.

Nuclear Safety Symposium

The KHNP has invited industries, universities, and laboratory experts from domestic and abroad and held a "Nuclear Safety Symposium" twice from 2005 to 2006. In 2005, current issues and the plans to enhance the safety of nuclear power plants in operation were introduced under the topic of "Enhancement of Safety of Nuclear Power Plants in Operation." Under the topic of "The Advance of Nuclear Safety and Operational Technology," presentations titled, "The Future of Example Application of Risk-Informed Regulation" and "Improving Plant Operation" were given during the Symposium in 2006.

Promotion for understanding the nuclear safety culture

In order to introduce its employees the concept and importance of nuclear safety culture, the KHNP has developed educational course materials and held classes on safety culture, for more than 2-week periods in the Nuclear Power Education Institute. Also, the KHNP has been providing special lectures on safety culture prepared by veteran nuclear experts and outstanding professionals for employees in the nuclear power plants. Safety culture can be improved through analyzing the employees' work ethics, safety consciousness, and analyses on practices that affect the safe operations of the nuclear installations. The fact that safe operation is achieved through fostering a good safety culture is the most economical method to run nuclear power plants is widely acknowledged in the nuclear power sector.

II.6 Financial and Human Resources (Article 11)

II.6.1 Financial and Human Resources of Licensee/Applicant

KEPCO, the owner of all the power plants in Korea, transacted the reorganization of electric power industrial structure to divide its power generation sector into 6 subsidiary companies in April 2001, in view of promoting efficiency in electric power business and maximizing the effect of services for the people with the introduction of competitive system. The power generation sector was separated into 5 thermal power generation companies (namely, South-eastern, Southern, Central, Western, and East-western Power Generation Corporation) and a hydraulic and nuclear power company, and will be privatized step by step. The KHNP will remain as a public entity so that the safety may not be jeopardized in pursuit of the profit.

The KHNP, a company which took all nuclear power-related installations and employees of KEPCO, is composed of the headquarter with ***4 divisions and 15 offices, branches with 4 nuclear power site divisions and 1 hydro power generation plant, and 5 special branches.*** Details of KHNP organization is shown in Figure II.6-1. With assets worth about ***22.2 trillion won,*** this Company has the personnel of ***7,300*** or so. Among ***7,300 employees,*** the persons engaged in the construction and operation of nuclear installations number approximately 6,100. (Figure II.6-1)

Each nuclear power plant of KHNP consists of various sections. The Director supervises ***the Quality Assurance Office, including the Community & Environment Cooperation Office. Under the Community & Environment Cooperation Office, there are the Community Cooperation section for cooperating with local communities, the Public Relations section, and the Emergency Prevention Preparedness & Environment section.*** Under General Manager, there is Safety Engineering and Support Section which co-ordinates nuclear safety matters. Under Operation Office, there are Operation section, Radiation safety section and Chemistry section. Under Maintenance and engineering Office, there are ***the System Engineering section, Program Engineering section,*** Mechanical engineering section, Electrical engineering section and ***the*** I&C section (Figure II.6-2).

In the KHNP headquarter, the Nuclear Review Board is placed for deliberating and making decision on nuclear safety. The Plant Nuclear Safety Committee (PNSC) is organized in each nuclear installation to advise the plant manager on the matters concerning nuclear safety.

II.6.2 Financing of Safety Improvements

The Government performs research and development to enhance safety as part of the Long-term Nuclear Energy Research and Development Program for the purpose of maintaining safe operation of nuclear installations and preparing for changes in regulatory standards resulting from the advancement of nuclear technology and environmental changes. To continuously perform research and development and to secure financial resources, the Atomic Energy Act stipulates specifics on the promotion of nuclear research and development programs and on the foundation of a nuclear research and development fund.

The nuclear research and development fund consists of the fee borne by the utility of nuclear installations. The fee is fixed at 1,200 won per MWh of nuclear power generation. The total budget estimated for the research and development program during the period from 200*7* to 20***11*** amounts to around ***2.4357*** trillion won and that consists of a nuclear R&D fund and a government subsidy amounting to ***2.0177*** trillion won and a private investment amounting to ***0.4180*** trillion won. The fund of nuclear safety research will be gradually increased importance of nuclear safety to considering.

Additionally, KHNP is implementing a nuclear development technology project ***from 2007 to 2015***, utilizing ***a total of 0.6592 trillion won from the Electric Industry Fund supported by the Electricity Business Act. The project aims to develop basic technologies for export of the power plant components and equipment, obtain the right of core technologies and secure a high level of operational technologies. The project includes sub-projects such as enhancing the nuclear safety through advancing the operational technologies.***

KHNP is replacing and/or reinforcing its facilities under the Mid- and Long-term Maintenance Program established for operational safety. As an example of investments in nuclear installations for the enhancement of safety, KHNP completed, in 1998, replacing steam generators, process control systems, reactor protection systems, plant monitoring systems, and field instruments in order to enhance the safety of Kori Unit 1, the oldest nuclear installation in Korea.

Furthermore, KHNP replaced reactor control rod guide tube supporting pins and nuclear fuel top nozzle spring screws with new ones. ***Also, the KHNP regularly checks the performance of motor operated valves and air operated valves, respectively.***

To be prepared for any disqualification of the plant safety-graded component manufacture or discontinuance of manufacture, KHNP developed a quality verification program (named as Dedication Program) to secure standardized products as the substitutes for the components of safety grade and it is now implemented.

II.6.3 Financial and Human Provisions for Decommissioning Program and Radioactive Waste Management

The Electricity Business Act stipulates that the operator of nuclear installations shall deposit the back-end cost for the purpose of decommissioning nuclear installations and permanently disposing of radioactive waste. According to this, the KHNP ***appropriates funds for*** the cost of decommissioning nuclear installations ***and disposing radioactive waste, based on the related standards every year***. The cost for the treatment of radioactive waste originated from nuclear installations, ***transportation, and on-site storage*** is included in the maintenance cost of nuclear installations.

The KHNP organized the Radiation Safety Office to take charge of ***the safety treatment of*** radioactive waste and the storage management of radioactive waste under the Safety & Technology Department in its head office. ***Each nuclear installation has a radiation safety section for such purpose. The cooperating companies such as the Korea Plant Service and Engineering Co., Ltd. (KPS), and others provide the required support for the treatment of radioactive waste and maintenance & management of disposal facilities***. Radioactive waste Disposal Facility Project Center is promoting the construction of radioactive waste ***disposal*** facilities and technical support is provided by ***Nuclear Engineering and Technology Institute.***

II.6.4 Qualification, Training, and Retraining of Personnel

The Atomic Energy Act stipulates that only the relevant license holder approved by the Minister of Science and Technology can operate the reactor or handle nuclear fuel materials, radioisotopes or radiation generating devices. The licenses are classified as follows:

- a license for senior reactor operator,
- a license for reactor operator,
- a license for senior nuclear fuel material supervisor,
- a license for nuclear fuel material supervisor,
- a license for senior radiation safety supervisor,
- a license for radioisotope supervisor and
- a license for radioisotope supervisor in medical use.

Licenses are issued to applicants who have engaged in the relevant fields with sufficient experience and successfully passed an examination administered by MOST. The license holders employed by ***KHNP, a total of 2,268 licenses (including double licenses)*** as shown in Table II.6-1. At regular intervals, the license holder must take a refresher course that KAERI, KHNP or KRIA holds by types of license. Technical specification specifies the qualifications of nuclear employees, and prescribes that all nuclear employees shall meet the specified qualifications.

The Atomic Energy Act stipulates that the operator of a nuclear Installation shall provide employees with educational and training opportunities. Accordingly, KHNP, an operator of nuclear installations, provides employees with professional experiences by annually improving the educational program. ***The educational program consists of an in-house training, on-site training, and commission training provided by domestic and oversea education facilities. Employees are required to complete compulsory training courses selected according to their respective fields and positions, as shown in Table II.6-2.***

The KHNP conducts a 3 week Operator Refresher Training, three times a year for reactor operators in rotation of mixed six-group shifts. Three groups rotate taking turns and the remaining three groups get trained, have day-off or perform the routine jobs in a mixed six-group shift. The major contents of the program consist of nuclear safety culture, simulator exercise, technical specifications, and a case study of incidents and accidents.

The Nuclear Power Education Institute of KHNP is operated for the purpose of developing nuclear expert manpower. This Institute is fully equipped with a simulator and various mock-up equipment including steam generator, fuel-reloading facility, and reactor coolant pump to enhance the maintenance capability of the personnel. At each nuclear installation site, the training center with simulator provides operators with re-training and simulator training program.

II.6.5 Regulatory Resources

KINS established the Mid-Long term Human resource development program to cope with the increasing demand of regulatory experts and implementing the program.

MOST strengthened the qualification requirement of ***nuclear*** regulatory inspectors for more stringent and better regulation of nuclear installations in January 2003 and it is presently applied. The areas of ***nuclear regulatory*** inspectors qualification are as follows; installation safety, radiation safety, emergency preparedness, quality assurance and nuclear materials accounting. The certificates are provided to the ***nuclear regulatory*** inspectors who have experiences more than 2 years as inspectors and finish relevant training courses.

The MOST established a "Nuclear Safety School" for cultivating professional manpower for nuclear safety on an international level and developing organized knowledge base in March 2004 under KINS. The school is intended for nuclear regulatory inspectors, governmental officers, employees in nuclear related industries, universities, and laboratories. In particular, nuclear regulatory inspectors are required to regularly complete related courses in the school.

The education program at the Nuclear Safety School consists of a "regulatory inspector course" for training and retraining of nuclear regulatory inspectors, "regulation special course" for strengthening expertise of nuclear regulatory inspectors, "safety special course" for expertise of safety workers in domestic nuclear related facilities, and "international training course" for employees dealing with foreign nuclear activities through the cooperation with international organizations or foreign nuclear regulatory bodies.

Table II.6-1 License Holders Employed in Reactor Facilities

(as of December 31, 2006)

Category / Field	Type of License	Number of Holders
Reactor	Senior Reactor Operator	***1,129 (986)***
	Reactor Operator	***1,037 (916)***
	Subtotal	***2,166 (1,902)***
Nuclear Fuel Materials	Senior Nuclear Fuel Material Supervisor	***54 (31)***
	Nuclear Fuel Material Supervisor	***12 (4)***
	Subtotal	***66 (35)***
Radioisotope	Senior Radiation Safety Supervisor	***831 (0)***
	Radioisotope Supervisor	***4,838 (262)***
	Radioisotope Supervisor in Medical Use	***792 (69)***
	Subtotal	***6,461 (331)***
Total		***8,693 (2,268)***

※ The figures in parentheses correspond to the number of license holders employed by KHNP

Table II.6-2 Training System of Employees in Nuclear Installations

<table>
<tr><th>Items</th><th colspan="3">Corporate Training</th><th colspan="6">Domestic & Overseas Commitment Training</th><th colspan="2">Site Training</th></tr>
<tr><td>Executive</td><td colspan="3">-</td><td colspan="6">4 courses including top management course</td><td colspan="2">-</td></tr>
<tr><td rowspan="3">Director/ Deputy General Manager</td><td colspan="2">Mgt policy, strategic Mgt</td><td rowspan="14">corporate culture, language, IT, other training course</td><td rowspan="3">Manager course attached to university</td><td></td><td rowspan="3"></td><td></td><td rowspan="14">domestic training courses on consign-ment</td><td rowspan="14">Language, IT etc training courses on consign-ment</td><td rowspan="6">Command, Supervision, Mgt training course</td><td rowspan="14">Site OJT inside & outside corporate</td></tr>
<tr><td colspan="2">High-level Quality Mgt course</td><td rowspan="8">domestic & overseas MBA courses</td><td rowspan="12">overseas training courses on consign-ment</td></tr>
<tr><td>compulsory</td><td>Managerial course</td></tr>
<tr><td rowspan="3">Senior Manager</td><td>compulsory</td><td>Advanced course</td><td rowspan="11"></td><td rowspan="10">domestic & overseas Master's and Doctor's courses</td></tr>
<tr><td>compulsory</td><td>middle manager course</td></tr>
<tr><td colspan="2">Newly-appointed middle manager course</td></tr>
<tr><td rowspan="3">Manager</td><td>compulsory</td><td>Advanced course</td><td rowspan="8">Individual training + Group training + Touring training</td></tr>
<tr><td>compulsory</td><td>Primary manager course</td></tr>
<tr><td colspan="2">Newly-appointed manager course</td></tr>
<tr><td rowspan="4">Assistant Manager</td><td>compulsory</td><td>Advanced course</td><td rowspan="5"></td></tr>
<tr><td>compulsory</td><td>Practical course</td></tr>
<tr><td>compulsory</td><td>Fundamental course</td></tr>
<tr><td colspan="2">New employee beginning course</td></tr>
<tr><td>Technical& Secretarial Service</td><td colspan="2">Technical development course</td><td colspan="2">Technical, official courses</td></tr>
</table>

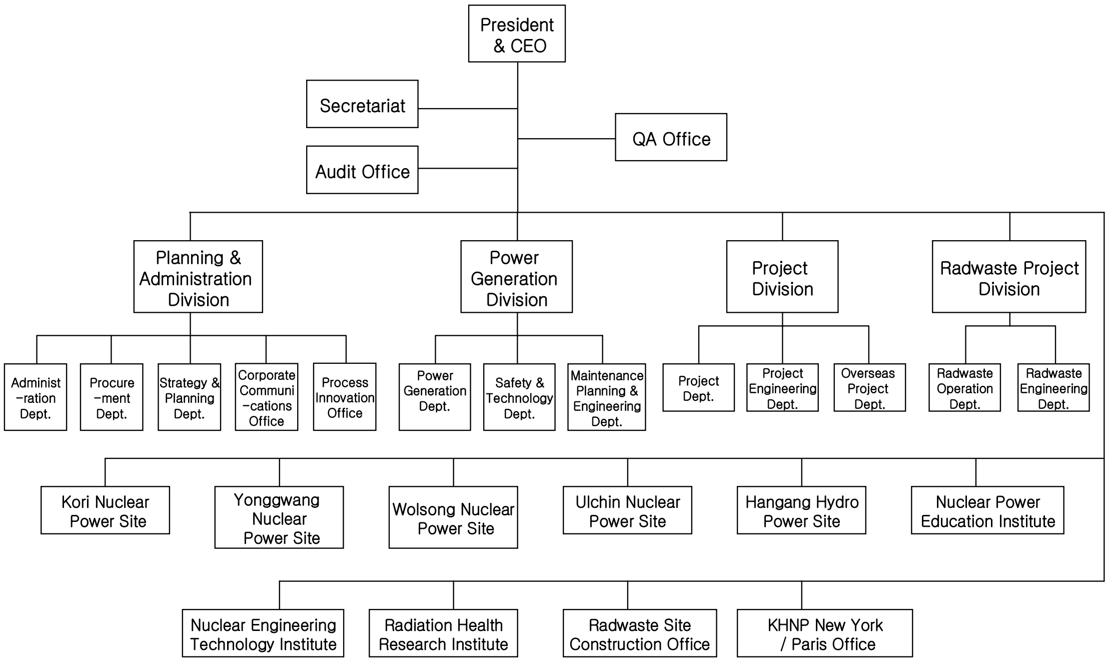


Figure II.6-1 Organization Chart for Korea Hydro & Nuclear Power Co., Ltd.

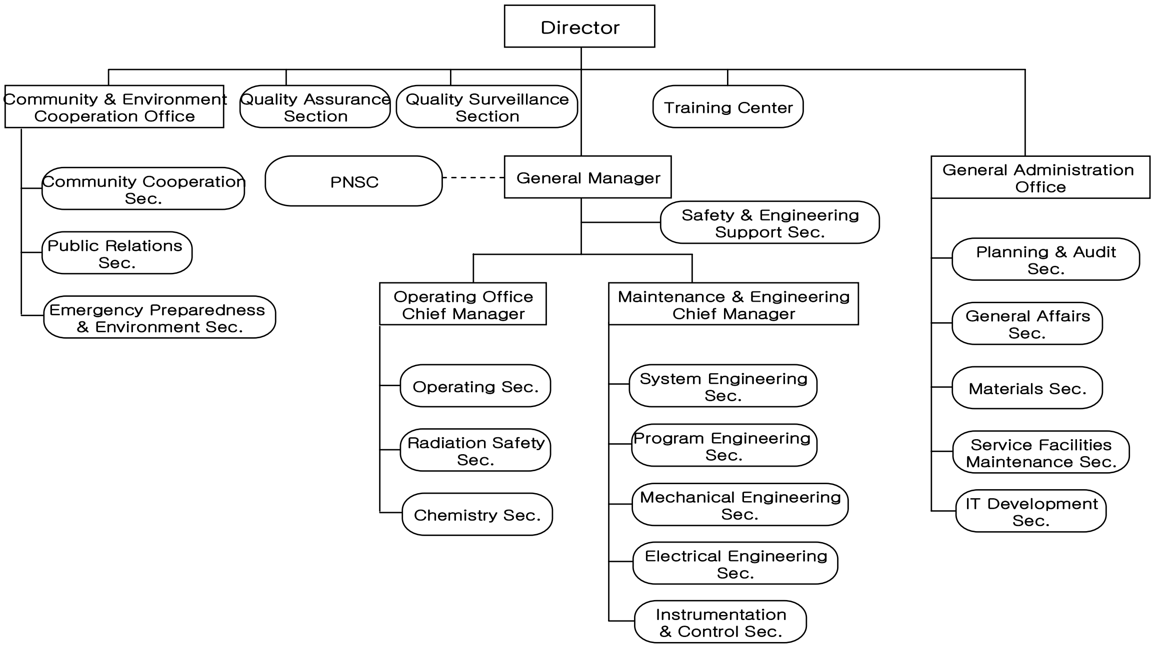


Figure II.6-2 Operating Organization Chart for Nuclear Power Plants in the KHNP

II.7 Human Factors (Article 12)

II.7.1 Prevention, Detection and Correction of Human Errors

Human Factor Engineering *(HFE)* in Design

The details of ***HFE*** shall be described in the SAR, which is to be filed to obtain CP and OL, in accordance with the Atomic Energy Laws. The principles for ***HFE*** are ***also*** consistently applied to any ***design modification of nuclear***. The ***HFE*** is ***applied*** through 4 stages, namely, ***the planning, analysis, design and verification and validation. The HFE program addresses the main control room, safety parameter display system (SPDS), remote shutdown room, technical support center (TSC), emergency operations facility (EOF), etc***. The KINS conducts a safety review for the SAR submitted by KHNP, an applicant for CP ***and OL***, and field inspections to verify whether ***HFE*** is properly reflected in the design.

Plant Operation to Minimize Human Errors

For the purpose of improving the human performance in nuclear installations, KHNP has formulated and operated since February 1990 the Human Performance Enhancement System (HPES). The HPES operational management procedures are based on the HPES procedures ***developed by*** the Institute of Nuclear Power Operation (INPO). To accurately ***and comprehensively*** analyze the root causes of human ***errors***, KHNP ***developed*** the ***Korean-HPES (***K-HPES***)*** in October 1993, of which the analysis procedure is reinforced in consideration of Korean working environments, and currently applies it to all nuclear installations. ***In 2006, KHNP developed a web-based K-HPES to enhance the applicability of human errors cases occurred during plant operation and to extend their usefulness by including near-miss accidents into the analysis.***

In addition, the CEO of KHNP announced the prevention of human errors to have the highest priority in operation. Also, KHNP has been continuously promoting the correction of human errors through Corrective Action Program (CAP) and Integrated Human Performance Program while reflecting on case studies of exemplary practices from foreign nuclear installations.

Installation and Utilization of Simulators

To reinforce the reactor operator's capability to cope with accidents and to prevent human errors, KHNP installed a simulator at each nuclear installation site as shown in Table II.7-1, and utilizes it for various operators training.

Feedback of Operating and Maintenance Experience

The KHNP prepared and now implements a procedure to share the important domestic and overseas operating and maintenance experiences, and to reflect them in the operation of nuclear installations. Since December 1999, the ***KHNP*** also has been promoting the effective utilization of the foreign technical information provided by IAEA, INPO, ***WANO***, etc. as well as of its domestic operating experience through the establishment of the KHNP Nuclear Information System. The KHNP, which publishes an accident or incident report or a report of operating and maintenance experience including near misses in the related nuclear installations, distributes them to all nuclear installations and nuclear-related organs, ***and*** periodically holds relevant workshops.

Consideration of Management and Organization

In 1992, the KHNP changed the reactor operator's working system of all nuclear installations from ***five groups taking three shifts to six groups taking three shifts. This change in operational organization took place to*** minimize human errors of reactor operators by reducing their work load and consolidating educational and training programs. ***By having six groups taking three shifts, three groups are able to take turns working while the remaining three groups receive training, take days off, or perform their routine jobs.***

From 2005, one shift supervisor and one safety technical advisor have been assigned to one reactor unit, whereas in the past, one person was assigned per two units. The reactor operator and the turbine operator who were previously working as general staff members were promoted to managers in order to improve the safe operation of nuclear installations.

II.7.2 *Role of Regulatory Body*

MOST, the regulatory body, establishes a regulatory policy for enhancing human performance, and provides strategic support to encourage excellent manpower to engage in nuclear power fields. ***In addition***, the MOST encourages the ***utility*** to improve nuclear installations with respect to ***HFE*** through licensing ***process*** and regulatory inspections for nuclear installations. MOST also devises institutional measures to incorporate human engineering into the design of nuclear installations. For example, MOST systematically enforced the post-TMI action to all operating nuclear installations through an administrative order. ***For the plants that had not chapter 18 "Human Factors" in their final safety analysis report***, ***relating to this enforcement, KINS has performed the safety review of a D-CRDR (Detailed-Control Room Design Review) and SPDS (Safety Parameter Display System) as a post-TMI actions from 1989 to 1994. During this process, the*** KINS recommended KHNP to correct ***various*** human engineering discrepancies.

In addition, the MOST devised institutional measures to evaluate the suitability of human factors from the beginning of the design stage, by adding a new chapter (Chap. 18) on human engineering to the preliminary SAR submitted for a CP of a nuclear installation. It has been applied to nuclear installations constructed after 1988.

Since July 2001, regulatory inspection on human factors for operating nuclear power plants has been institutionalized for improving the check-up of human factor in operating nuclear power plants. Through this, safety inspection on human ***factors*** is ***commonly*** conducted during planned overhaul outage to verify whether design modification, operation and maintenance management of plant facility, human factor analysis and implementation of its results, and modification of field equipments are performed properly. Based on the inspection results, corrective ***actions and*** measures are implemented for the enhancement of human performance and nuclear safety.

Table II.7-1 Status of Simulators

	Simulator 1	Simulator 2	Simulator 3	Simulator 4	Simulator 5	Simulator 6	*Simulator 7*
Station	Kori Unit 1,2	Kori Unit 3,4 Yonggwang Unit 1,2	Ulchin Unit 1,2	Yonggwang Unit 3,4,5,6	Wolsong Unit 1,2,3,4	Ulchin Unit 3,4,5,6	***Yonggwang Unit 1, 2***
Manufac turer	KEPCO, Samsung, Hyundai	W/H	Thomson-CSF	KEPCO, Samsung, Hyundai	CAE	KEPCO, Samsung, KOPEC, Samchang	***W/H***
Reference plant	Kori 2 PWR 2 Loops	Yonggwang 1,2 PWR 3 Loops	Ulchin 1,2 PWR 3 Loops	Yonggwang 3,4 PWR 2 Loops	Wolsong 2 PHWR 2 Loops	Ulchin 3,4 PWR 2 Loops	***Yonggwang 1, 2 PWR 3 Loops***
Date of installation	1998. 7	1986. 12	1990. 2	1997. 4	1996. 12	2002.10	***2006.9***
Place	Nuclear Power Education Institute	Nuclear Power Education Institute	Ulchin NPP	Yonggwang NPP	Wolsong NPP	Ulchin NPP	***Yonggwang NPP***

II.8 Quality Assurance (Article 13)

II.8.1 Quality Assurance Policy

The Atomic Energy Act stipulates that the installer and operator of nuclear installations shall formulate a quality assurance system, and establish and implement a quality assurance program in order to ensure systematic quality assurance activities in every stage of the design, procurement, manufacturing, installation, commissioning, operation, maintenance and decommissioning of the nuclear installations.

According to this provision, the applicant for a CP or an OL shall file a quality assurance program manual for the construction or operation of a nuclear installation, accompanying an application for CP or OL, with the Minister of Science and Technology for approval. They must comply with the quality assurance program during the construction and operation of nuclear installations.

<u>Harmonization of Safety Regulation of Nuclear Power Plants</u>

Since the frequency of unscheduled reactor trip in non-safety related facilities is higher than that of safety related facilities, it was decided that KINS would perform the regulation for the secondary system; this was previously carried out by the Korea Electrical Safety Corporation (KESCO) based on the Electricity Enterprises Act. Accordingly, KINS performs the harmonized regulation for both primary and secondary systems based on Atomic Energy Act in accordance with the amendment of Notices of the MOST for nuclear facility application.

To ensure consistency in coordination of regulation, nuclear utility and suppliers are currently in the process of updating their quality assurance programs, this process aims to set up design, manufacturing, construction and operation of reactors and related facilities in the quality assurance programs. It includes the structures, systems and components of the primary and secondary systems which are directly and indirectly related to unscheduled reactor trips.

II.8.2 Quality Assurance Program

As for the framework of quality assurance programs, the Enforcement Regulation Concerning the Technical Standards of Reactor Facilities, etc. (Quality Assurance Criteria for Reactor Facility Construction and Operation), and the KINS Guidelines stipulate 18 criteria for the quality assurance program as follows:

(!)organization, (2)quality assurance program, (3)design control,(4)procurement document control, (5)instructions, procedures, and drawings, (6)document control, (7)control of purchased material, equipment, and services, (8)identification and control of materials, parts, and components, (9)control of special processes,(10)inspection, (11)test control, (12)control of measuring and test equipment, (13)handling, storage, and shipping, (14)inspection, test, and operating status, (15)nonconforming materials, parts, or components, (16)corrective action, (17)quality assurance records, and (18)audits.

A comprehensive assessment for the adequacy, effectiveness and practicability of a quality assurance program submitted by licensee and its subcontractors is performed by KINS during the process of safety review in accordance with the Atomic Energy Laws, the safety review guidelines and the quality assurance guidelines for nuclear installations prepared by KINS.

II.8.3 Implementing and Assessing Quality Assurance Programs

KHNP, an installer and operator of nuclear installations, requires all contractors who participate in the construction and operation of nuclear installations to prepare and implement a quality assurance program pursuant to the Atomic Energy Laws and SAR. KHNP is responsible for maintaining integrated quality assurance program for nuclear power plants and also making all subcontractors implement its own quality assurance program.

All contractors involved in nuclear projects, including design, construction, operation and maintenance, are performing quality-related activities in accordance with regulatory requirements. All subcontractors' quality-related activities are verified by KHNP and the regulatory inspection of KINS.

The assessment for the implementation and effectiveness of the quality assurance program is periodically conducted by KHNP to verify whether quality assurance activities are being properly implemented by KHNP itself, the contractor and sub-contractor, in accordance with the quality assurance program. The method of assessing the implementation of a quality assurance program includes quality control inspection, quality assurance audit, quality trend analysis, and assessment of the effectiveness of quality assurance program.

- Quality Control Inspection is conducted by a qualified inspector on the basis of the pre-established inspection plan. Before starting the quality control inspection, the inspector selects the inspection points (witness point and hold point) in the inspection plan and then executes the inspection.
- Quality Assurance Audit is periodically conducted by a qualified auditor for both the internal organizations and external contractors considering the characteristics of activities.
- Quality Trend Analysis is conducted to revise the quality assurance program and to improve the quality assurance system. This is achieved by establishing recurrence-preventive measures and improvement plans from investigation on the causes of conditions adverse to quality such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and non-conformances that are identified during the quality control inspection and quality assurance audit.
- Assessment for a quality assurance program effectiveness is periodically conducted by the quality assurance organization to maintain the quality assurance program suitable for the features of nuclear installations. Major considerations given to the assessment for quality assurance programs include the issuance and amendment of related regulatory requirements, corrective actions or recommendations made by the regulatory body, changes in quality assurance policy, the revision of the applied technical standards, and the results of a self-quality assurance audit.

The responsible person of the quality assurance organization takes proper measures in time by reporting to a top manager the important issues resulted from the assessment of the implementation and effectiveness of the quality assurance program. Further efforts are made to maintain the quality assurance program as a living document by revising the corresponding quality assurance program, if necessary, after such assessment of effectiveness.

II.8.4 Regulatory Control Activities

The regulatory control activities concerning quality assurance are conducted through reviews and inspections by KINS, as entrusted by the Government. These activities are performed based on the Atomic Energy Laws and the safety review guidelines and the quality assurance guidelines for nuclear installations as prepared by KINS.

The safety review of quality-related activities is conducted to verify whether the quality assurance system is sufficient to implement the quality assurance program in accordance with the Atomic Energy Laws and the safety review guidelines. It also verifies whether the quality assurance procedures for the implementation of the program are properly established and practicable. The objectives of regulatory inspections for quality-related activities are to verify whether each organization participating in the design, manufacturing, construction, and operation of nuclear installations has performed quality-related activities in accordance with the quality assurance program, and whether the program has been effectively implemented so as to ensure the safety and reliability of nuclear installations.

In order to encourage voluntary and active quality assurance activities from the licensees, KINS has developed the "Guidelines for the Assessment of Licensee's Quality Assurance Activities", and is carrying out a distinctive regulatory inspection by class, after quantifying the results of the regulatory inspections of the quality assurance activities of the licensees. In accordance with "Quality Assurance Inspector Qualification System" for regulatory personnel established by KINS, the qualified inspectors who completed the specified educational and training courses currently and qualified as Quality Assurance Inspectors conduct quality assurance inspections.

<u>Introduction of Quality Management System within Regulatory Body</u>

KINS has established a quality management program based on IAEA Safety Standards Series No. GS-R-3, "The management system for facilities and activities" in order to improve the public trust and the reliability of the regulatory body. The quality management program addresses the policy, purpose, and responsibility of the quality of regulatory activities according to nuclear regulatory policy of government, including a comprehensive quality management system in order to carry out

standardized tasks such as quality planning, management, evaluation, and improvement.

As shown in picture II.8-1, the comprehensive document system for quality management of regulatory activities is categorized into four sections.

- *A quality management plan describing the quality management system according to the quality policy of regulatory body,*

- *A set of work standards to identify the operation provisions of the entrusted assignments obtained the government's permission according to the Atomic Energy Act,*

- *A set of detailed and standardized guideline for implementing regulatory activities and*

- *A set of procedures describing how to conduct regulatory activities.*

The details of the quality management program led to the core operational areas comprised of ten (10) functional categories that are consistent with 1) general matters, 2) regulatory policy, 3) safety review, 4) safety inspection, confirmation, and surveillance, 5) research and development on regulatory technology, 6) nuclear safety measures, 7) security of radiation source and accident response, 8) nuclear related license examinations, 9) PR and information disclosure and 10) evaluation of regulatory activities. The general matters include basic contents in order to achieve quality management of regulatory activities, such as responsibility and authority, establishment of the work standards and confirmation, a human resource planning and document management.

Also, each chapter describing plans for a specific area defines the scope of application scope, responsibility, plans, and procedure. The detailed activities in each chapter should be supplemented by work standards, guidelines, and procedures.

An independent quality expert team with organizational freedom performed evaluations for quality management system of KINS twice in 2006. Based on the result of the first evaluation, some parts of the quality management program for the nuclear safety regulation was revised and supplemented accordingly and made further systematic approach to regulatory process a necessity. In the second

evaluation, corrective actions and recommendations were identified for improving the efficiency of regulatory activities by evaluating the performance in tasks entrusted by the government. They included main considerations that should be addressed by the regulatory organization in order to perform proper quality management.

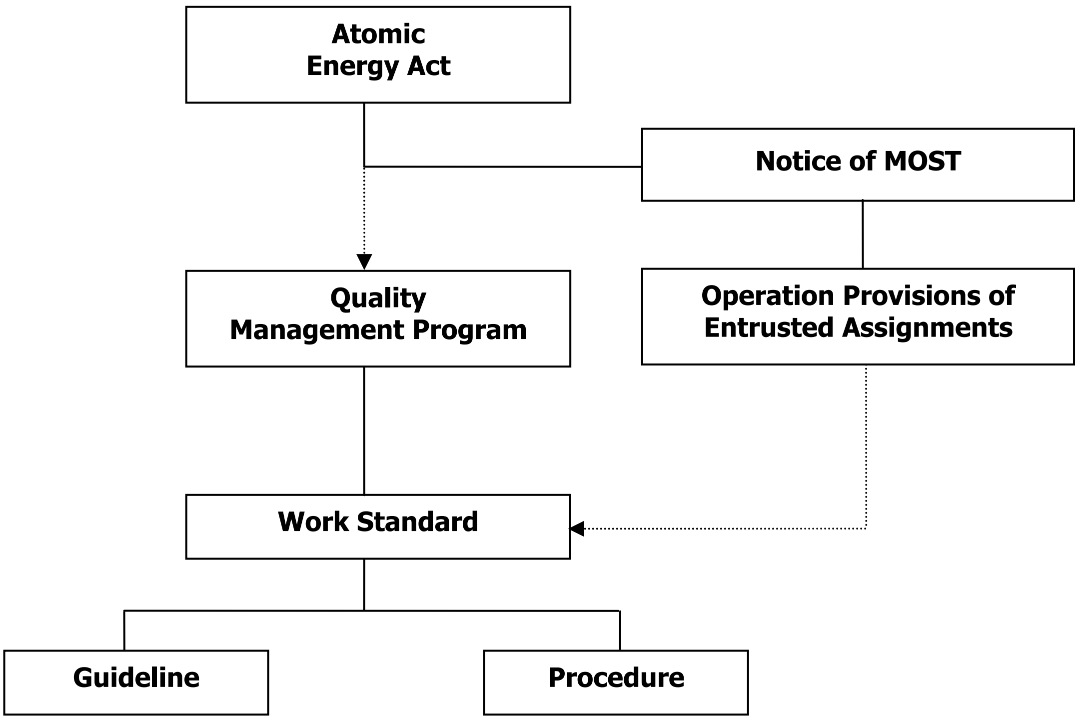


Figure II.8-1 Quality Management Documentation Structure of Regulatory Activities

II.9 Assessment and Verification of Safety (Article 14)

II.9.1 Licensing Procedure and Safety Analysis Report

Pursuant to the Atomic Energy Act, the licensing procedure for nuclear installations, as described in Section II.2.3, consists of two stages: the CP and the OL. The applicant for a SDA, a CP or an OL shall conduct comprehensive and systematic safety assessments to ensure that the public and the environment are protected from potential radiation hazards which may accompany the construction and operation of nuclear installations.

If the applicant intends to construct reactors of the same design, it can obtain a SDA, which would substantially reduce the CP and OL review process by exempting the scopes already reviewed in the process. The applicant who wishes to obtain SDA must submit a standard design safety analysis report. The applicant who wishes to obtain CP and OL must submit a preliminary and final SAR together with a radiological environmental assessment report to the Minister of Science and Technology.

The SAR includes results of the entire safety assessment of nuclear installations, such as the design features of structures, systems and components of nuclear installations, structural integrity, evaluation of system performance, human engineering, design basis accidents, radiation protection, and site characteristics.

Technical Specifications and Quality Assurance Programme which have been independent reports, were added to SAR and become a part of it. The contents of the SAR are prescribed in the Enforcement Regulation of the Atomic Energy Act, and applied to all types of reactors, as shown in Table II.9-1. The probabilistic safety assessment has been conducted by the license holder for newly constructed nuclear power plant by the recommendation of regulatory body. However, after the severe accident policy was declared in August 2001, this probabilistic safety assessment is being conducted for operating plants as well.

The radiological environmental assessment report includes an assessment of the radiological effects on the public and environment, and as prescribed in the Enforcement Regulation of the Atomic Energy Act, it includes the following items:

- the environmental state of all areas around the nuclear installation and its site,

- the estimation of radiological impacts on surroundings due to the construction and operation of nuclear installations,
- a radiological environmental monitoring program to be implemented during the construction and operation of nuclear installations, and
- the radiological environmental impacts resulting from accidents which may occur during the operation of nuclear installations.

Further details are described in the Notice ***No. 2005-19*** of the Minister of Science and Technology, as titled "Regulation on Preparation of Evaluation Statement of Environmental Impact by Radiation at Nuclear Facilities".

II.9.2 Continued Monitoring and Periodic Safety Review

1) Safety Assessments Using Deterministic Method

Safety Assessment for Reload Core

KHNP conducts a safety evaluation for the reload core of all PWR installations at every refueling. The reload safety evaluation includes the design of reload core, power capability, accident evaluation, any modification to technical specifications, and acceptability of peaking factors. KINS, as entrusted by MOST, conducts regulatory inspections to ensure the safety of reload core.

Periodic Inspections and Assessments for Nuclear Installations

To assess the safety and continuous operability of nuclear installations, KHNP carries out overall safety inspections including In-Service Test (IST) and In-Service Inspection (ISI) during the planned preventive maintenance period of 20 month intervals.

Separately from the safety inspections by KHNP, KINS conducts a periodic regulatory inspection for operational nuclear installations. ***Since April 2005, KINS has included the secondary system into its inspection scope***. The Minister of Science and Technology determines whether or not to allow the reactor to reach criticality by comprehensively assessing the safety and performance of nuclear installations with the result of a regulatory inspection.

The details of the overall safety inspections performed by KHNP, and the periodic regulatory inspections by KINS are described in Section II.9.3 and II.9.4.

2) Probabilistic Safety Assessment (PSA)

KHNP conducts probabilistic safety assessments for pre-operational and operational nuclear installations in compliance with severe accident policy declared by regulatory body. It has been making efforts for continuously improving the safety of reactor installations on the basis of the results. Several examples of implementing the result of PSA are given as follows:

- ***For Kori Unit 1, 2, 3 and 4, the KHNP installed an Alternate Alternating Current (AAC) and for Yonggwang Units1, 2, and Ulchin Unit 1, 2, detailed designing process is going on to install an AAC*** in order to enhance a capability of coping with station blackout.

- As for Yonggwang Unit 3, 4, 5 and 6, and Ulchin Unit 3, 4, 5 and 6, that is, of Korean Standard type PWR, the KHNP improved the reliability of auxiliary feed water system, and installed an additional AAC in order to enhance a capability of coping with station blackout. A safety depressurization system was also installed to heighten the depressurization capability of reactor system.

- As for Ulchin Unit 3, 4, 5 and 6, and Yonggwang Unit 5 and 6, the KHNP modified the design of reactor cavity, and installed hydrogen ignitors in order to enhance a capability of coping with severe accidents, further to all the improvements made at Yonggwang Units 3 and 4. The KHNP also provided a penetrator for containment exhaust filter.

- The necessity for installing hydrogen ignitor at Wolsong Unit 1, PHWR-type reactor, to mitigate damages in containment building when severe accident occurs is under review. In Wolsong Unit 2, 3 and 4, PHWR-type installations as well, hydrogen ignitors have been installed. In order to increase safety against earthquakes, they were improved and reinforced with a part of equipments with a seismic design for the pump buildings of an emergency water supply system.

For the purpose of enhancing the capability of coping with severe accidents, KHNP continues establishing a severe accident management plan for nuclear installations as followed.

- ***Accident management plans for Korean Standard type PWRs have been provided and applied to Yonggwang Unit 3, 4, 5 and 6, Ulchin Unit 3, 4, 5 and 6 (OPR1000), and Kori Unit 1, 2, 3 and 4, Yonggwang Unit 1 and 2 (WH-type)***
- ***Accident management plans for Ulchin Unit 1 and 2, Framatom-type PWR are under planning.***

The results of a probabilistic safety assessment are shown in the core damage frequency (CDF) in Table II.9-2, and no nuclear installations with vulnerabilities were found that may seriously affect safety.

3) Periodic Safety Review

The NSC resolved to introduce the PSR system that reviews the safety of operating nuclear power plants comprehensively and systematically considering operating experiences, owner's safety activities and effect of ageing, etc. in the 11th committee meeting of December 21, 1999.

Accordingly, the legislation for PSR was completed through the revision of the Atomic Energy Act in January ***2001,*** Enforcement Decree of the Act and Enforcement Regulation of the Act in July 2001.

The relevant bills stipulate that operator of nuclear power plant shall comprehensively assess the safety of each NPP and related facilities every 10 years after an OL is issued, and report the assessment results thereof to the Minister of Science and Technology. The assessment scope is based on 11 safety factors such as actual condition of the NPP, safety analysis and equipment qualification.

The assessment is to be carried out as an individual assessment of the 11 safety factors and, as for the safety factors related to others, combined assessment shall be conducted. The safety shall be comprehensively assessed based on all of the individual assessment results and also the safety measures taken according to the assessments. ***Regarding***

the assessment criteria, the valid technical standard in safety assessment can be applied to corresponding nuclear installations.

Following the decision of the NSC, KHNP undertook a periodic safety review from May 2000, after submitting a plan for Kori Unit 1 of a demonstration plant to MOST**,** and submitted the results to MOST in November 2002. MOST had reviewed the results for one year since December 2002***. As of December 2006, KHNP undertook periodic safety reviews for Kori Unit 1, 2, 3 and 4, Yonggwang Unit 1, 2, 3 and 4, Wolsong Unit 1 and Ulchin Unit 1 and 2. The regulatory body completed the review of the reports from those units, except for Yonggwang Unit 3, 4 and Ulchin Unit 1, 2.*** Table II.9-3 shows the time schedule for the first PSR of the NPPs.

4) Monitoring and Assessment of Safety performance and Public Release

Monitoring and Assessment of Safety-related Parameters

KHNP conducts a continued monitoring and assessment for the safety-related parameters listed below, and the data on unplanned reactor scrams and the capacity factor during last 10 years are shown in Table II.9-4**:**

- unplanned reactor scrams,
- actuation and failure of safety-related systems,
- human actions against all incidents including human errors, and
- tendency and practices of all maintenance including periodic maintenance.

In order to minimize the radiological impacts on nearby residents and surrounding environment following the operation of nuclear installations, KHNP sets the limits of radioactive effluent release and controls the release to the environment. KHNP also continuously monitors the effect on the environment. According to the environmental radiation monitoring program, and periodically collects and analyzes environmental samples, continuously checking the environmental radiation level with the environmental radiation monitoring system. Based on the data, KHNP evaluates the off-site dose to the population every month. The details of the radioactive material release and the environmental radiation monitoring system are described in Section II.10.2. and II.11.2.

Development and improvement of Safety Performance Indicators (SPI)

In Korea, the Safety Performance Indicators (SPI) system was developed jointly by the MOST and KINS, and applied first to the operating PWRs in 1995 to analyze performance trend, to monitor long-term safety status of NPP operation, to allocate regulatory resources properly and to improve public confidence in nuclear safety by providing operational information.

The Korean SPI system was restructured for improvement in 2002 reflecting SPIs developed by the IAEA and US Nuclear Regulatory Commission(USNRC). The evaluation of SPIs is being performed once every quarter and the results are posted on the Web-site, http://opis.kins.re.kr.

The SPI system is composed of 2 safety areas, 5 categories and 11 indicators (Table II.9-5) which represent the performance of nuclear power plants. The four colors representing the performance grades ***are green, cyan, yellow, and orange***, each of which stands for excellent, good, normal and warning grade, respectively. The grades were determined considering regulatory requirements such as safety limits and limiting conditions for operation in Technical Specification. Figure II.9-1 shows the evaluation results of SPIs for all the domestic NPPs for the fourth quarter ***in 2006***.

II.9.3 Verification Program

Preventive Maintenance

KHNP carries out preventive maintenance to prevent any failure by preserving the operating condition and performance of nuclear installations within the design limits, in accordance with the provisions referred to in the guide for operational technique of each nuclear installation. The current methods for preventive maintenance are classified into daily surveillance and verification, periodic preventive maintenance, predicted maintenance and planned preventive maintenance, etc.

KHNP systematically manages the information on preventive maintenance by using a computer program named "Power Unit Maintenance System for Nuclear-Version II" which is developed by KHNP to ensure accuracy and reliability of information control.

Such information includes intervals of preventive maintenance, equipment history, trend analysis, and reflection of results.

In-Service Inspection (ISI) and In-Service Test (IST)

Pursuant to the Enforcement Decree of the Atomic Energy Act and the Notice of the Minister of Science and Technology, KHNP submits an ISI program for each nuclear installation at 10-year intervals to the Minister, and conducts necessary inspections. The Notice No. ***2004-13*** of the Ministry of Science and Technology (titled "Regulation on In-Service Inspection of Reactor Facilities") stipulates that the ISIs shall be conducted in accordance with ***KEPIC (Korea Electric Power Industry Code) MI section*** or Code Section XI (Rules for In-service Inspection of Nuclear Power Plant Components) of the American Society of Mechanical Engineers(ASME) for PWR and in accordance with CAN/CSA-N285.4 (Periodic Inspection of CANDU Nuclear Power Plant Components) for PHWR ***and CAN/CSA-N285.5 (Periodic Inspection of CANDU Nuclear Power Plant Containment Component)***.

The Notice No.2004-14 from the Ministry of Science and Technology (titled "Regulation on In-Service Inspection of the Safety-related Pump and Valve") prescribes that ***KEPIC MO section*** or Section XI of the Section IST of the ASME Operation and Maintenance Code shall be applied to both PWR and PHWR when In-Service Test. Pumps must undergo several tests for operating parameters including pressure, flow rate and temperature, along with the analysis of the result of test being made to ascertain any change in reference values of the parameters, in accordance with the provisions specified in ***KEPIC MOB section*** or Subsection ISTB of Section IST. As for valves, it includes the leakage test, the actuation test, and the position indicating test and fail-safe test, together with analysis of the result of tests being performed to ascertain any change in reference values, in accordance with the provisions specified in ***KEPIC MOC section or*** Subsection ISTC of Section IST.

Aging Process Evaluation

The KHNP conducts aging process evaluations of major components, systems, and structures through the preventive maintenance program and the ISI and IST programs. The data collected through the ISIs and ISTs are used as reference data for aging mitigation programs or maintenance programs.

As for the reactor pressure vessel, the variation in the impact absorption energy and the nil-ductility transition temperature is periodically examined through specimen surveillance. The welding parts of the reactor pressure vessel, steam generator, pressurizer, and major pipes are examined by ultrasonic inspection to identify the existence of any flaws or the possibility of any crack growth. The steam generator tubes and the turbine rotors are inspected during planned preventive maintenance to identify the existence of any flaws or the possibility of any crack growth. As for major rotating machines, valves, and heat exchangers, the existence of performance degradation is checked and evaluated through the ISTs. The performance degradation of snubbers, thickness thinning of pipes, corrosion levels of underground laid materials, and so on are continuously monitored and evaluated.

The KHNP applied for continued operation of Kori Unit 1 on June 16, 2006. The KHNP safety assessment report on continued operation, which evaluated the management plan of monitoring system for aging process for the next 10 years, is currently under regulatory reviewing process. The safety assessment for continued operation covers two areas. The first is the assessment on Structures, Systems, and Components (SSCs) and non-safety-related SSCs which might have an impact on the safety-related SSCs. The other is on fire protection system, environment qualification, pressurized thermal shock, station blackout and anticipated transient without scram. The KHNP established the aging management programs for passive components with long lifetime among selected SSCs.

For the life management of Wolsong Unit 1 which is a PHWR-type plant, KHNP has completed the first stage of researches on the life assessment and the replacement plan for main equipments, the establishment of ***feederpipe*** thinning control plan, and the development of a real-time thinning monitor, and the second stage ***of research is going on lifetime managements. The programs for the in-depth lifetime assessments and the aging management program for individual equipment are in preparedness.*** A project is a foot to gradually initiate and expand the study of life management as well as the periodic safety review for other nuclear installations.

Safety Assessment for *the Air-Operated* and the Motor-Operated Valves

The KHNP ***completed*** a design-based safety assessment for safety-related motor operated valves from 1999 ***to July, 2005***. Through this safety assessment it is feasible to select the worst operating condition expected in the design-based conditions, and make a related test to ascertain the properness of switch set points, with the result of checking full opening or full closing function, that is, a safety function proper to motor operated valves. As for the valves hard to test under the design-based conditions, a safety verification can be made by a substitute method. Any proper corrective action is necessary to secure safety for the valve that needs improvements in safety function as a result of safety assessment.

Additionally, KHNP formulated a program to check whether the thermal binding and the pressure locking of safety-related power operated gate valve does hinder the safety function of gate valve. The examination of the valve configuration, and the system design condition permit to select a valve expected to have the vulnerability to thermal binding and pressure locking, and valve functionality ***were*** secured through tests or analyses with the proper corrective measures, if necessary. ***Some of the valves with potentials of pressure locking were modified and improved.***

The Notice No. 2004-14 (July 2, 2004) of the Ministry of Science and Technology stipulates that the periodic verification program be prepared. According to the Notice, periodic verification programs regarding the motor-operated valves, which completed the design basis safety evaluation as of June, 2005 are to be implemented in all NPPs.

Meanwhile, KHNP developed the relevant technology in November, 2006 since the Notice above requires safety assessment for the air-operated valves similar to the motor-operated valves. The KHNP will start design basis performance assessments in January, 2007 and plans to complete it by July, 2010. After completion, KHNP plans to continuously check on the performance of the motor-operated valves and the air-operated valves through periodic verification programs during the plant lifetime.

Development of Dedication Program

The regulatory guide of KINS requires that KHNP should develop a quality verification program and to assure the substitution of standardized products by safety-graded ones by way of preparedness against any disqualification for nuclear quality assurance or any production discontinuity of the nuclear power plant safety-graded component manufacturer.

KHNP confirmed the adequacy of the reserved items on site by the quality verification program and some relevant procedures developed in accordance with the regulatory guide of KINS. It also provided the technical personnel in charge with the training for improving their capability.

This program will permit to determine the essential properties which any component should possess as a safety one through the analyses of safety function and breakage type for the components of main equipments, and to verify them with tests and inspections. However, for special test items that cannot be performed by KHNP, some competent quality expert companies would perform the works as subcontractors.

II.9.4 Regulatory Control Activities

As part of the regulatory control activities for the safety assessment and verification of nuclear installations, safety reviews and regulatory inspections are conducted at the design and construction stage to verify whether the nuclear installation is designed in conformity with regulatory requirements and technical standards. In the case of operating nuclear installations, periodic inspections are conducted to confirm whether the safety regulatory requirements and limiting conditions for operation are complied with. KINS carries out these safety reviews and inspections, as entrusted by the Minister of Science and Technology in accordance with the Atomic Energy Act.

At the stage of the CP, the suitability of a site and the safety of proposed designs are, as major matters, subject to safety reviews. At the stage of the OL, the integrity of facilities, the operating method of installations, and the plan for emergency response are, as major matters, subject to safety reviews. In the operational stage, PSR report submitted by operator is subject to the safety review of regulatory body as well.

The regulatory inspection is classified into the pre-operational and the periodic inspection. The objective of those inspections is to verify whether the installer or operator of nuclear installations properly implements the relevant requirements and licensing basis conditions. KINS conducts regulatory inspections of the safety and performance of each nuclear installation during the planned outage every 20 months. ***KINS started to conduct the safety regulation on the secondary system that used to be under the control of MCIE (the Ministry of Commerce, Industry and Energy) and KESCO (the Korea Electrical Safety Corporation) in April, 2005***. The facilities and items subject to regulatory inspections for PWR and PHWR are described in Table II.9-6 and Table II.9-7.

Meanwhile, in order to legislate the PSR system for checking the safety of nuclear power plants which have run for more than 10 years, MOST amended the Atomic Energy Act in 2001, and also revised the Enforcement Decree and the Enforcement Regulations of the same Act reflecting necessary particulars for the enforcement of this amended Act. ***The provision on continued operation after the design lifetime of nuclear power plants was added to the Decree on Periodic Safety Review in September, 2005. KINS developed the review guidelines for both the Periodic Safety Review report and the continued operation.***

Table II.9-1 Contents of SAR of Nuclear Installations

	Contents
General Items	1. Introduction and General Plant Description 2. Site Characteristics 3. Design of ***Structures***, Components, Equipment, and Systems 4. Reactor 5. Reactor Coolant System and Connected Systems 6. Engineered Safety Features 7. Instrumentation and Controls 8. Electric Power 9. Auxiliary Systems 10. Steam and ***Power Conversion System*** 11. Radioactive Waste Management 12. Radiation Protection 13. Conduct of Operations 14. Initial Test Program 15. Accident Analyses 16. Technical Specifications 17. Quality Assurance Programme 18. Human Factor Engineering
Others	- Probabilistic Safety Assessment (PSA)

Table II.9-2 **Core Damage Frequency of Nuclear Installations**

Station Name	**CDF(/RY)***
Kori Unit 1	$\boldsymbol{1.19\times10^{-4}}$
Kori Unit 2	$\boldsymbol{3.77\times10^{-5}}$
Kori Unit 3 & 4	$\boldsymbol{8.38\times10^{-6}}$
Yonggwang Unit 1 & 2	$\boldsymbol{7.25\times10^{-6}}$
Yonggwang Unit 3 & 4	$\boldsymbol{4.74\times10^{-6}}$ **
Yonggwang Unit 5 & 6	$\boldsymbol{5.46\times10^{-6}}$ **
Ulchin Unit 1 & 2	$\boldsymbol{7.96\times10^{-6}}$
Ulchin Unit 3 & 4	$\boldsymbol{5.44\times10^{-6}}$ **
Ulchin Unit 5 & 6	$\boldsymbol{3.65\times10^{-6}}$ **
Wolsong Unit 1	$\boldsymbol{3.29\times10^{-5}}$ **
Wolsong Unit 2, 3 & 4	8.02×10^{-6}

* Internal events were considered.

***** Updated analysis results***

Table II.9-3 Schedule for the First PSR of the NPPs

	Implementation Schedule										
	'00	**'01**	**'02**	**'03**	**'04**	**'05**	**'06**	**'07**	**'08**	**'09**	**'10**
Kori Unit 1	5		11								
Wolsong Unit 1		5		6							
Kori Unit 2			4	12							
Kori Unit 3,4			7		6						
Yonggwang Unit 1,2				7		6					
Ulchin Unit 1, 2						1	12				
Yonggwang Unit 3, 4					3		3				
Wolsong Unit 2							8		5		
Ulchin Unit 3, 4								5		5	
Wolsong Unit 3, 4								7		6	

Table II.9-4 Some Parameters of Nuclear Installations

(a) Reactor Scrams at Nuclear Installations

Year	Kori				Yonggwang						Ulchin						Wolsong				Total	Opera -ting Unit	Rate
Year	1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	Total	Opera -ting Unit	Rate
97	2	2	1	0	1	2	1	5	-	-	4	5	-	-	-	-	0	4	-	-	27	12	2.3
98	0	2	2	0	0	0	0	0	-	-	1	0	0	-	-	-	2	2	2	-	11	14	0.8
99	1	2	2	0	1	5	1	1	-	-	1	0	1	0	-	-	1	1	0	0	17	16	1.1
00	1	0	1	1	0	0	0	2	-	-	1	1	1	1	-	-	0	0	0	0	9	16	0.6
01	0	0	0	0	0	2	0	0	-	-	5	5	0	0	-	-	0	2	2	0	16	16	1.0
02	2	0	0	0	1	1	0	1	1	0	3	0	1	2	-	-	1	1	0	0	14	18	0.8
03	2	2	1	1	4	0	1	1	3	0	1	1	0	1	-	-	0	1	1	1	21	18	1.2
04	1	0	1	1	0	1	0	1	2	0	0	1	0	1	1	-	1	1	1	0	13	19	0.7
05	3	1	1	1	0	1	0	0	0	1	0	2	3	0	2	1	1	0	0	0	17	20	0.9
06	0	0	1	0	1	1	2	0	1	0	1	1	1	1	0	1	0	1	1	0	13	20	0.7
Total	12	9	10	4	8	13	5	11	7	1	17	16	7	6	3	2	6	13	8	1	158	169	0.9

(b) Capacity Factors of Nuclear Installations

(unit : %)

Year	Kori				Yonggwang						Ulchin						Wolsong				Average
Year	1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	Average
97	78.9	86.1	75.8	87.8	103.9	83.5	87.0	81.7	-	-	85.9	88.8	-	-	-		102.1	97.1	-	-	87.6
98	77.6	87.5	86.5	105.3	89.1	75.5	89.0	101.2	-	-	96.0	92.8	103.7	-	-		78.5	83.6	98.5	-	90.2
99	85.2	87.1	90.5	89.0	84.5	84.3	89.1	91.8	-	-	89.4	97.9	83.5	-	-		82.8	90.8	82.0	103.0	88.2
00	92.3	91.3	100.9	91.3	90.3	89.4	87.3	87.3	-	-	90.0	85.2	90.1	84.7	-		80.9	92.7	103.0	94.2	90.4
01	95.0	89.4	94.7	95.1	104.4	89.9	103.6	87.1	-	-	87.5	91.6	94.9	93.1	-		83.1	97.2	86.0	95.5	93.2
02	85.4	93.9	96.1	106.0	92.9	102.5	92.1	92.1	103.3	105.3	71.3	82.0	93.0	88.1	-		99.1	91.6	95.8	94.7	92.7
03	93.2	90.2	104.8	95.1	88.7	92.8	93.9	102.9	81.1	92.5	87.6	90.9	104.4	95.4	-		89.5	95.3	97.3	98.2	94.2
04	94.8	101.9	91.6	92.0	90.1	90.5	91.8	91.5	66.9	76.6	93.1	91.3	94.8	103.3	102.8	-	90.3	94.9	96.4	97.4	91.4
05	85.2	95.8	94.7	104.9	103.8	91.5	104.1	93.3	93.6	94.0	103.8	83.0	92.2	96.1	88.3	103.7	77.7	98.1	104.5	98.4	95.5
06	90.2	91.4	88.4	88.8	91.1	99.6	87.5	99.9	88.9	91.8	87.7	96.0	96.8	90.7	90.6	85.2	91.4	99.7	94.0	100.4	92.3
Average	87.8	91.5	92.4	95.5	93.9	90.0	92.5	92.9	85.4	88.8	89.2	90.0	94.2	93.1	91.8	92.6	87.5	94.1	95.1	97.2	91.6

Table II.9-5.   Structure of SPI System

Area	*Category*	*Performance Indicator*
Reactor Safety	***Operational Safety***	***- Unplanned Reactor Scram*** ***- Unplanned Power Reduction***
	Multiple Barrier	***- Fuel Reliability*** ***- Reactor Coolant Leakage*** ***- Containment Reliability*** ***- Emergency Preparedness***
	Safety System	***- SI System Unavailability*** ***- EDG System Unavailability*** ***- AFW System Unavailability***
Radiation Safety	***On-site Rad. Safety***	***- On-site Radiation Dose***
	Off-site Rad. Safety	***- Off-site Radiation Level***

Table II.9-6 **Facilities and Items Subject to Periodic Inspection for PWR**

Facilities	Items Subject to Inspection
Reactor (including Fuel)	- Used Fuel Assembly Integrity - Zero Power Reactor Physics Test - On-Power Reactor Physics Test - Reactor Head Penetration Inspection
Reactor Coolant System	- ISIs of Safety Class 1, 2, and 3 Systems - Steam Generator Eddy Current Test - Reactor Coolant Flow Rate Measurement - Reactor Coolant System Leakage Test
Instrument and Control System	- Engineered Safety Feature (ESF) Response Time Measurement - Reactor Protection System Response Time Measurement - Control Rod Drop Time Measurement - Control Rod Position Indication System Functional Test - ESF Slave Relay Actuation Test - Safety-related Instrumentation Calibration - Seismic Monitoring System - Loose Part Monitoring System - Emergency Shutdown Pannel - Fire Detection and Alarm System
Fuel Handling and Storage System	- Fuel Transfer Facilities - Spent Fuel Pool Cooling and Purification System
Radioactive Waste Management System	- Radioactive Waste Management System - Ventilation System Filter Functional Test - Water Chemistry Management
Radiation Control System	- Health Physics Plan and Implementation - Radiation Measuring and Monitoring System - Environmental Radiation Monitoring System - Meteorological Monitoring System
Reactor Containment System	- ***Containment*** Integrated Leak Rate Test - ***Containment*** Local Leak Rate Test - Containment Isolation System - Containment Spray System - Containment Combustible Gas Control System - ***Containment Liner Plate In-service Inspection***
Reactor Safety System	- Residual Heat Removal System - Emergency Core Cooling System - Refueling Water Storage Tank

Electrical Power Supply System	- Emergency Diesel Generator Test - ***Generator System*** Test - ***Transformer System Test*** - ***Switchyard System Test*** - ***On-site Electrical System Test***
Power Conversion System	- ***Main Feedwater System*** - ***Auxiliary Feedwater System*** - ***Main Condenser and Vacuum System*** - ***Turbine and Generator System*** - ***Main Steam Safety Valves*** - ***Turbine Rotor Integrity*** - ***Turbine Control and Protection System***
Other Reactor Safety Related System	- Component Cooling Water System - Nuclear Service Water System - Compressed Instrument Air System - Snubber - Chemical and Volume Control System, - Essential Chilled Water System - Fire Protection System - Seismic Class Structure Integrity - Heating, Ventilation, and Air Conditioning - ***Safety-related Pump and Valve In-service Test***
Emergency Preparedness Facilities	- Emergency Preparedness Facilities
Management Technology	- Operating Organization and Employee's Qualification - Education and Training - Emergency Operation Procedure - Operational Experience Feedback - Human Factor Management - Withdrawal of Irradiated Specimen

Table II.9-7 **Facilities and Items Subject to Periodic Inspection for PHWR**

Facilities	Items Subject to Inspection
Reactor	- Reactor Criticality - Flow Rate of Fuel Channel - Fuel Channel Elongation - Power Distribution of Fuel Channel - Volumetric inspection of Fuel Channel
Reactor Coolant System	- ISIs of Safety Class 1, 2, and 3 Systems - Steam Generator Eddy Current Test - Primary Heat Transport (PHT) Pump - PHT System Liquid Relief Valve Stroking Time Test - Feeder Grayloc - Degasser Condenser Relief Valve Test, - Shutdown Cooling System - Heavy Water Feed and Bleed System
Instrument and Control System	- PHT System Functional Test - Shutoff Rod Drop Test - Shutdown System # 1 Functional Test - Shutdown System # 2 Functional Test - Calibration of Safety-related System Instrumentation - Seismic Monitoring System - Fire Detection and Alarm System - Channel Calibration of Post Accident Monitoring System
Fuel Handling and Storage System	- Fueling Machine - Spent Fuel Pool Cooling and Purification System - Spent Fuel Discharge and Emergency Cooling System
Radioactive Waste Management System	- Radioactive Waste Management System - Ventilation System Filter Functional Test - Water and D_2O Chemistry Management
Radiation Control System	- Health Physics Plan and Implementation - Radiation Measuring and Monitoring System - Environmental Radiation Monitoring System - Meteorological Monitoring System
Reactor Containment System	- ***Containment*** Integrated Leak Rate Test - Containment Local Leak Rate Test - Containment Isolation ***System*** Test - ***Containment Hydrogen Igniter Test*** - ***Containment Post-tensioning System In-service Inspection***
Reactor Safety System	- Emergency Core Cooling System, - Emergency Water Supply System - Special Safety System Poised State

	- Reactor Building Dousing System
Electrical Power Supply System	- Emergency Diesel Generator Test - ***Generator System*** Test - ***Transformer System Test*** - ***Switchyard System Test*** - ***On-site Electrical System Test***
Power Conversion System	- ***Main Feedwater System*** - ***Auxiliary Feedwater System*** - ***Main Condenser and Vacuum System*** - ***Turbine and Generator System*** - ***Main Steam Safety Valves*** - ***Turbine Rotor Integrity*** - ***Turbine Control and Protection System***
Other Reactor Safety-related System	- Recirculating Cooling Water System - Raw Service Water System - Moderator System - Compressed Instrument Air System - HVAC - Main Steam Safety Valve Test - Snubber - Safety & Relief Valve - Safety-relate Pump and Valve Test - Fire Protection System - Annulus Gas System - Differential Settlement of Containment Building - Seismic Class Structure Integrity - Calandria Vault Light Water Leak
Emergency Preparedness Facilities	- Emergency Preparedness Facilities
Management Technology	- Operating Organization and Employee's Qualification - Education and Training - Emergency Operation Procedure - Operational Experience Feedback - Human Factor Management - Withdrawal of Irradiated Specimen

Quarter 2006 4/4

Area	Reactor Safety									Radiation Safety	
Category	Operational Safety		Multiple Barrier				Mitigating System			On-Site Rad.	Off-Site Rad.
Indicator	URS	UPR	FR	RCL	CR	EP	SI	EDG	AFWS	RCD	PD/ER
Kori-1	G	G	G	G	G	G	G	G	G	G	G
Kori-2	G	G	G	G	G	G	G	G	G	G	G
Kori-3	G	G	G	G	G	G	G	G	G	C	G
Kori-4	G	G	G	G	G	G	G	G	G	G	G
Ulchin-1	G	G	G	G	G	G	G	G	G	G	G
Ulchin-2	Y	G	G	G	G	G	G	G	G	G	G
Ulchin-3	C	C	G	G	G	G	G	G	G	G	G
Ulchin-4	G	G	G	G	G	G	G	G	G	G	G
Ulchin-5	G	G	G	G	G	G	G	G	G	G	G
Ulchin-6	G	G	G	G	G	G	G	G	G	G	G
Wolsong-1	G	G	G	G	G	G	G	G	G	G	G
Wolsong-2	G	G	G	G	G	G	G	G	G	G	G
Wolsong-3	G	G	G	G	G	G	G	G	G	G	G
Wolsong-4	G	G	G	G	G	G	G	G	G	G	G
Yonggwang-1	G	G	G	G	G	G	G	G	G	G	G
Yonggwang-2	C	G	G	G	G	G	G	G	G	G	G
Yonggwang-3	G	G	G	G	G	G	G	G	G	G	G
Yonggwang-4	G	G	G	G	G	G	G	G	G	G	G
Yonggwang-5	G	G	G	G	G	G	G	G	G	G	G
Yonggwang-6	G	G	G	G	G	G	G	G	G	G	G

Grade	Excellent	Good	Normal	Warning	Not Available	No Data	Under Development
	G	C	Y	O	N	D	U
Total	215 Cases	4 Cases	1 Case	0 Case	0 Case	0 Case	0 Case

Figure II.9-1 The Evaluation Result of SPIs for the Fourth Quarter in 2006

II.10 Radiation Protection (Article 15)

II.10.1 Laws, Regulations and Requirements

The Atomic Energy Act prescribes the basic matters on radiation protection to be applied to nuclear installations, as follows:

- provisions on protective measures against radiation hazards that keep the radioactive material release and the occupational radiation exposure to be as low as reasonably achievable (ALARA),
- provisions on safety measures relating to operations stipulating the necessary actions to be taken for protecting human bodies, materials, the public, and the environment from radiation hazards which may accompany the operation of nuclear installations,
- criteria for the registration of a business related to the personnel dosimetry service for any person who is employed in, or who has access to nuclear installations, and
- training requirements for the workforce involving radiation exposure.

The Enforcement Decree of the Atomic Energy Act specifies the detailed requirements for implementing the basic matters on radiation protection referred to in the Act, while the Enforcement Regulations of the Act includes the detailed procedure and method for executing the Enforcement Decree as follows:

- Radiation dose limits related to radiation protection (The dose limits defined by this regulation are as shown in Table II.10-1),
- Detailed regulations to minimize the exposure of the workers engaged in radiation work, the persons who have frequent access to nuclear installations, and the population living around the said installations,
- Detailed provisions necessary for implementing protective measures against radiation hazards, such as the action to be taken for the radiation overexposure accident, and relevant reporting,
- Detailed provisions necessary for implementing the radiological control measures such as criteria and access control of radiologically controlled area,
- Detailed provisions on the criteria for the registration related to a license for personnel dosimetry service,

- ***Detailed provisions on the peculiar radiation workers, such as damaging or losing the personal dosimeter and those whose radiation dose measurement is more than the specified limits and***
- ***Provisions on the legal dosimeters for radiation workers.***

Subparagraph 5 of Article 2 and the Table 1 in the Enforcement Decree of the Atomic Energy Act specify the dose limits, while the Notice No. 2002-23 of the Minister of Science and Technology (titled "Standard on Radiation Protection, etc.") prescribes technical requirements such as effluent control limits.

II.10.2 Implementation of Laws, Regulations and Requirements

1) Radiation Exposure Control and Reduction

Implementation of ALARA in the Design and Construction of Nuclear Installations

KHNP incorporates the following radiation protection principles in the design and construction of nuclear installations, for assuring ALARA and maintaining the radiation doses to workers and the general public within the applicable limits:

- radioactive equipment to be installed separately in the shield room with a partition,
- installation of shields to fully attenuate radiation from pipes and equipment containing large amounts of radioactivity,
- use of remote controlled equipment and automatic equipment,
- installation of ventilation facilities in areas of potential air contamination,
- installation of a continuously operating radiation monitoring system in nuclear installations, and
- appropriate zone classification and access control.

Criteria for Radiation Exposure Control

KHNP established a target dose limit for radiation workers at 80% of the legal limit, as shown in Table II.10-1, and controls radiation doses to maintain within the target dose limit. It is prescribed in the procedures that any person whose annual dose reaches the target value shall not perform any more radiation work during which they are expected to be additionally exposed above the target value, unless the approval of the plant manager is given or any proper measure is taken.

Management of Radiation Work

KHNP prescribes in the procedures that any person who intends to have access to controlled areas and to perform radiation work, should obtain approval in advance in the form of a radiation work permit. This is prepared separately in consideration of the radiation work type, the radiation level, and the working area conditions. For issuance of the radiation work permit, the radiation control personnel is to evaluate the expected dose in consideration of the working environment and conditions, and if necessary, to further impose any special conditions on the worker.

In the management of access to the controlled zones, KHNP linked the RAM (RAdiation safety Managements system) with ERP (Enterprise Resource Planning) systems in the year 2003. The system is continuously upgraded to improve the reliability and efficiency of radiation managements in nuclear power plants. With this system, KHNP has computerized the enrollments of workers, the access to controlled zone, the work permit, the personal dose exposure data, and the radiation level management. As a result, KHNP can collect and manage various statistical data and hence, improve the efficiency of radiation safety management.

Dose Reduction

KHNP establishes and operates target values for reducing occupational radiation exposure according to classified categories, such as the annual collective dose, collective dose during planned preventive maintenance period, and the job-specific collective dose. KHNP prescribes in the procedures that any radiation work shall be conducted following the plan, as established before undertaking the work. It is also prescribed that the ALARA Committee shall be held from the planning stage to estimate and evaluate the radiation level and the expected collective dose, and to further evaluate ALARA performance more than once a year, in respect of major maintenance work, design modification, and replacement of equipment. When conducting radiation work, the technique for reducing doses shall be described in the radiation work procedure or the radiation work permit. It is required for radiation workers to utilize the technique after evaluating the application result of the technique to any past work. Trends of radiation exposure of radiation workers in nuclear installations are shown in Table II.10-2.

Personnel Dosimetry Service and Inspection for Dosimeter

All the persons engaged in personnel dosimetry service, including KHNP, transact personnel dosimetry services with an approval of the Minister of Science and Technology, and monthly distribute, collect, and reads thermoluminescence dosimeters (TLDs). The result should be notified to the individuals and reported to the Government on a quarterly basis, and the calibration and the performance verification for the reader are conducted every 6 months. TLD periodically undergoes a standardized performance inspection and a periodic inspection which meet the international criteria in order to secure objectivity and reliability in the personnel dosimetry.

Radiation Protection Training

KHNP prescribes in the procedure that radiation workers and the personnel having access to nuclear installations shall take appropriate radiation protection training courses. Workers acquire basic knowledge and handling skills needed for radiation work through training. The curriculum is classified into the following courses:

- course for personnel of occasional access,
- course for radiation workers,
- refresher course,
- course for any offenders, and
- course for managers.

The training duration is assigned differently for each course in consideration of the specialty of each course. ***Educational subjects include the safety management for the use of nuclear facilities, the treatment of radioactive materials, the protection of radiation hazards, and the regulations on radiation safety management. Additional subjects include radiation exposure control, waste managements, detector management, access procedure, contamination control, the use of instruments and protective equipment. The personnel who have taken the training courses shall be evaluated using proper tools including written examination. If the results of the***

evaluation are above a pre-established level, the personnel will be qualified. The disqualified personnel should re-take the exam as well as training courses. If they fail the evaluation more than the pre-established number of times, the personnel will be prohibited to the access of the controlled area.

Establishment and Operation of the National Safety Management Center for Radiation Workers

As the number of radiation workers continuously increases with the expansion of nuclear facilities and radiation related industries in Korea, it has become necessary to systematically control occupational exposures with the ALARA principle. Thus, KINS established the National Safety Management Center for Radiation Workers, on November 27, 2002 supported by MOST.

The center operates the Korea Information System on Occupational Exposure (KISOE), which is an internet-based expert system that enables analysis and evaluation of occupational exposures and lifetime tracking of individual worker dose. The main functions of the KISOE are as follows:

- Maintaining radiation protection record of radiation workers through analysis of individual dose,
- Feedback of radiation risk information into regulatory activities,
- Use in verification of regulatory effectiveness through analysis of radiation effects on workers and derivation of quantitative indicators for radiation safety management according to the type of radiation usage,
- Introduction of the concept of lifetime dose management of radiation workers and production of basic data on optimization of occupational exposure by analysis of the characteristics of workplace environment, and
- Establishment of an information network system related with international databases such as ICRP, the United Nations Scientific Committee on the Effects of Atomic Radiation(UNSCEAR), and Information System on Occupational Exposure(ISOE) of OECD/NEA.

The MOST has authorized the KRIA to establish and operate RIS (Radiation workers Information System) since August, 2005. The RIS can synthetically classify, operate, and perpetually manage the radiation exposure, health medical examination,

educational & training of about 30,000 workers in 3,000 radioactive source using companies. The MOST has strengthened safety management for radiation workers through the close connection between KISOE and RIS.

2) Requirements for Radioactive Effluent Release

The Enforcement Decree of the Atomic Energy Act and the Notice No. ***2002-23*** of the Minister of Science and Technology ***(titled, " Standards on Dose Exposure Protection" by the Notice Radiation 001 of the Ministry of Science and Technology.)*** prescribe effluent control limits of gaseous and liquid radioactive effluents to be released from nuclear installations into the environment, along with the annual dose constraints of the population living around nuclear installations.

The dose constraints for gaseous effluent on the exclusion area boundary by a unit of nuclear power plant, which are specified in the Notice of the Minister of Science and Technology, are as follows:

- Air absorbed dose by gamma rays	: 0.1 mGy/yr
- Air absorbed dose by beta rays	: 0.2 mGy/yr
- Effective dose from external exposure	: 0.05 mSv/yr
- Skin equivalent dose	: 0.15 mSv/yr
- Organ equivalent dose from internal exposure to particulate radioactive substance, H-3, C-14, and radioiodine	: 0.15 mSv/yr

The dose constraints for liquid effluents on the exclusion area boundary by a unit of nuclear power plant are as follows:

- Effective dose	: 0.03 mSv/yr
- Organ equivalent dose from internal exposure	: 0.1 mSv/yr

The annual dose constraints on the exclusion area boundary per site in operating multiple units within the same site are as follows:

- Effective dose : 0.25 mSv/yr
- Thyroidal equivalent dose : 0.75 mSv/yr

According to this, KHNP discharges gaseous or liquid effluents into the environment after confirming that the released effluents is less than the prescribed effluent control limits. The trend of annual release of liquid and gaseous effluents per site and off-site dose is shown in Table II.10-3.

Assessment of Radiation Doses to the Population around Nuclear Installations

The radiation dose to and its effect on the population around nuclear installations are assessed monthly by using the Off-site Dose Calculation Manual (ODCM). The assessments are based on the radioactivity of released liquid and gaseous effluents, atmospheric conditions, metabolism, and social data including ***the intake of*** agricultural and marine products of the local community within a radius of 80 km.

II.10.3 Regulatory Control Activities

The safety regulatory activities for radiation protection are classified into safety reviews, regulatory inspections, and development of technical standards. In the safety review, items are examined regarding ALARA assurance of radiation exposure to workers, source term assessment, characteristics of radiation protection design, dose assessment health physics program, and the appropriateness of equipment. The regulatory inspection confirms whether or not the radiation monitoring system in nuclear installations is appropriately operated. It also confirms that any personal exposure to radiation is maintained as low as reasonably achievable by checking the health physics program, the procedures for the radiation exposure control, the ALARA program, and the radiation work management.

There are some important issues on safety regulatory activities, such as the reduction of dose limits and the more active application of the ALARA principle.

Table II.10-1 Dose Limits

Category	Occupational	Frequent Access Personnel & Transport Worker	General Public
Effective Dose	100 mSv in a consecutive five-year period, subject to a maximum effective dose of 50 mSv in any single year	12 mSv per year	1 mSv per year
Equivalent Dose			
- Lens of the eye	150 mSv per year	15 mSv per year	15 mSv per year
- Skin, Hands and Feet	500 mSv per year	50 mSv per year	50 mSv per year

1) "consecutive five-year period" means the period for every 5 years from any given year (for example, 1998~2002). This calculation is not applicable to any period before 1998.
2) As for the general public, the value over 1 mSv to a single year is acceptable within the limit of not exceeding 1 mSv per year on the average of values for five years.
3) Article 4 of the Notice 2002-23 of the Minister of Science and Technology specifies that for female radiation workers who have declared pregnancy to her employer, the equivalent dose limit to the surface of the woman's abdomen (lower trunk) is 2 mSv for the remainder of pregnancy and the intake limit of radionuclides is 1/20 of the Annual Limit on Intake(ALI). Where there are both external and internal radiation exposures, the sum of the ratio of external exposure to 2 mSv and the ratio of intake of radionuclides to ALI/20 should not exceed 1.

Table II.10-2 Exposure Dose of Radiation Workers in Nuclear Installations

Unit: Collective Dose (man-Sv/yr), Average Individual Dose (mSv/yr)

Dose for Plant \ Year		1998	1999	2000	2001	2002	2003	***2004***	***2005***	***2006***
Kori Unit 1 & 2	Collective Dose	4.56	2.62	1.73	1.43	0.78	1.43	***0.98***	***1.97***	***1.43***
	Average Individual Dose	2.31	1.69	1.21	1.03	0.63	1.03	***0.66***	***1.37***	***0.82***
Kori Unit 3 & 4	Collective Dose	1.85	2.42	1.29	2.36	1.74	2.36	***2.33***	***1.77***	***2.34***
	Average Individual Dose	1.42	1.51	0.90	1.57	1.32	1.57	***1.37***	***1.13***	***1.22***
Yonggwang Unit 1 & 2	Collective Dose	3.17	2.05	2.32	1.24	1.05	1.24	***1.88***	***1.04***	***1.23***
	Average Individual Dose	2.43	1.54	1.52	0.95	0.91	0.95	***1.24***	***0.80***	***0.92***
Yonggwang Unit 3 & 4	Collective Dose	0.61	1.01	0.94	0.55	1.06	0.55	***1.30***	***0.69***	***0.68***
	Average Individual Dose	0.45	0.74	0.70	0.44	0.82	0.44	***0.89***	***0.53***	***0.49***
Yonggwang Unit 5 & 6	Collective Dose	-	-	-	-	0.06	-	***0.40***	***0.87***	***0.78***
	Average Individual Dose	-	-	-	-	0.06	-	***0.26***	***0.55***	***0.53***
Wolsong Unit 1 & 2	Collective Dose	2.87	2.77	1.81	1.72	1.09	1.72	***1.70***	***2.10***	***1.00***
	Average Individual Dose	2.17	2.15	1.37	1.44	0.94	1.44	***1.18***	***1.35***	***0.71***
Wolsong Unit 3 & 4	Collective Dose	0.14	0.64	0.40	0.96	1.44	0.96	***1.63***	***0.92***	***1.33***
	Average Individual Dose	0.11	0.49	0.40	0.86	1.24	0.86	***1.26***	***0.76***	***1.08***
Ulchin Unit 1 & 2	Collective Dose	1.27	0.82	2.15	1.93	1.37	1.93	***2.07***	***1.26***	***1.08***
	Average Individual Dose	1.20	0.82	1.64	1.52	1.18	1.52	***1.43***	***0.97***	***0.81***
Ulchin Unit 3 & 4	Collective Dose	0.03	0.36	0.74	0.55	0.72	0.55	***0.48***	***0.94***	***0.52***
	Average Individual Dose	0.02	0.28	0.52	0.43	0.53	0.43	***0.43***	***0.62***	***0.41***
Ulchin Unit 5 & 6	Collective Dose	-	-	-	-	-	-	***0.25***	***0.37***	***0.56***
	Average Individual Dose	-	-	-		-	-	***0.17***	***0.26***	***0.34***

Reference: White Paper on Nuclear Safety of 2006

Table II.10-3 The Trend of Annual Release of Liquid and Gaseous Effluents per Site and Off-site Dose *(1/2)*

Unit : TBq

Site \ Year		1998	1999	2000	2001	2002	2003
Kori	Liquid	2.05E-05	4.51E-06	1.45E-05	1.96E-05	3.63E-05	1.03E-04
	Gaseous	3.25E+00	3.50E+00	1.75E+00	7.38E+00	9.86E+00	1.06E+01
	Off-site dose (mSv)	2.07E-03	4.88E-03	3.61E-03	6.41E-03	2.70E-03	2.08E-03
Yonggwang	Liquid	Less than LLD	Less than LLD	1.96E-05	1.39E-05	8.51E-04	3.92E-03
	Gaseous	6.50E+00	6.75E+00	3.43E+00	8.79E-02	9.53E+00	1.55E+01
	Off-site dose (mSv)	7.34E-04	1.14E-03	2.65E-03	1.59E-03	6.85E-03	5.98E-03
Ulchin	Liquid	Less than LLD	Less than LLD	2.99E-05	2.67E-05	1.31E-04	2.07E-05
	Gaseous	7.13E-02	2.25E-01	3.30E+00	1.06E+01	4.02E+01	1.71E+00
	Off-site dose (mSv)	9.94E-04	1.13E-03	1.03E-.3	3.31E-03	2.36E-02	3.37E-03
Wolsong	Liquid	Less than LLD	Less than LLD	2.89E-04	3.69E-04	4.58E-04	4.88E-04
	Gaseous	1.61E+02	1.04E+02	5.29E+01	1.31E+02	1.52E+02	4.36E+01
	Off-site dose (mSv)	1.72E-03	2.32E-03	3.50E-03	4.43E-03	1.10E-03	5.32E-04
Total	Liquid	2.05E-05	4.51E-06	3.53E-04	4.30E-04	1.48E-03	4.53E-03
	Gaseous	1.71E+02	1.15E+02	6.14E+01	1.49E+02	2.11E+02	7.14E+01

LLD: Lower Limit of Detection

Table II.10-3 The Trend of Annual Release of Liquid and Gaseous Effluents *per Site and Off-site Dose (2/2)*

Unit : TBq

Site \ *Year*		*2004*	*2005*	*2006*
Kori	*Liquid*	*334E-05*	*2.34E-05*	*2.80E-05*
	Gaseous	*6.02 E+00*	*3.71E+00*	*6.58E+00*
	Off-site dose (mSv)	*5.22 E-03*	*5.12E-03*	*6.64E-03*
Yonggwang	*Liquid*	*2.55 E-02*	*1.82E-02*	*1.17E-02*
	Gaseous	*5.19 E-02*	*2.38E-02*	*2.72E-02*
	Off-site dose (mSv)	*5.77 E-03*	*2.85E-03*	*4.85E-03*
Ulchin	*Liquid*	*1.89 E-04*	*1.05E-03*	*7.20E-04*
	Gaseous	*2.68 E+00*	*1.22E+00*	*1.84E-01*
	Off-site dose (mSv)	*2.42 E-03*	*338E-03*	*1.65E-03*
Wolsong	*Liquid*	*5.29 E-04*	*3.93E-04*	*4.47E-04*
	Gaseous	*3.38 E+01*	*2.09E+01*	*3.49E+01*
	Off-site dose (mSv)	*4.6 E 1-03*	*3.01E-03*	*3.48E-03*
Total	*Liquid*	*2.63 E-02*	*1.97E-02*	*1.29E-02*
	Gaseous	*4.26 E+01*	*2.59E+01*	*4.17E+01*

II.11 Emergency Preparedness (Article 16)

II.11.1 Laws, Regulations, and Requirements

Radiological emergency preparedness is based on the ***Act on Physical Protection and Radiological Emergency***, ***the Basic Act of Disasters and Safety Control and Basic Act of Civil Defense*** which stipulates a national preparation against radiological accidents. Under the ***Basic Act of Disasters and Safety Control***, the MOST is responsible for formulating a master plan every 5 years and a yearly implementation plan based on the master plan. The local governments and agencies concerned shall yearly make a detailed implementation plan, according to the master plan and the yearly implementation plan.

For preparation against radiological accidents, the Act on Physical Protection and Radiological Emergency prescribes that a nuclear licensee shall submit a radiological emergency plan to the MOST for approval before the beginning of its facility operation. The detailed criteria for formulating radiological emergency plans are referred to in the Notice No. ***2004-11*** of the Minister of Science and Technology (titled, "***Standards for Preparation of Radiological Emergency Plan of a Nuclear Licensee*** "). The same Notice, which was formulated in 1996, was revised mainly for the particulars of ***emergency planning zones, response facilities, the types and contents of emergency exercises and time to submit the exercise plans and results*** in August, 1998, August, 2003 and ***June, 2004***.

It contains the following:

- ***the emergency planning zone and general provisions,***
- ***the duties and organization of emergency preparedness organizations,***
- ***the criteria for announcement of radiological emergency,***
- ***the emergency response facilities,***
- ***the response activities for emergency,***
- the reentry and recovery,
- the emergency training and exercises,
- the public education and information, and
- the responsibility for the maintenance and management of emergency plan.

Especially, Physical Protection and Radiological Emergency Act was legislated in May 2003, in order to establish effective domestic system of physical protection of nuclear materials and nuclear facilities and to prepare legal and institutional basis for preventing radiological disaster and constructing countermeasures against radiological emergency. This Law came into force in February 2004.

II.11.2 Implementation of Emergency Preparedness Measures

The national radiological emergency plan (the master plan and the yearly implementation plan of MOST) consists of 5 parts, namely, the establishment of emergency response organization, emergency classification and response, protective measures, emergency response facilities and equipments, and emergency training and exercises, as shown in Table II.11-1.

Classification of Emergency Situations

Radiological emergencies at nuclear installation site are classified into white emergency (alert), blue emergency (site area emergency), and red emergency (general emergency) according to the severity of accident. The emergency action levels are based on the conditions of nuclear installations, the instrument indications, and the on-site and off-site radiation levels.

- White Emergency: Events are in progress or have occurred which involve actual or potential substantial degradation of the safety level of nuclear installations. The release of radioactive material is expected to be limited within the structures of the nuclear installation.

- Blue Emergency: Events are in progress or have occurred which involve actual or likely failures of major safety functions due to the degradation of the recovering function to safety condition. The release of radioactive material is expected to be limited within the boundary of the nuclear installation.

- Red Emergency: Events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with the potential for loss of the last barrier integrity, thus anticipating a large release of radioactive material beyond the boundary of the nuclear installation.

If any accident occurs in nuclear installations, the operator shall immediately report the emergency situation to the Minister of Science and Technology and the local government, in accordance with the Notice No***. 2005-07*** of the Minister of Science and Technology (titled, "***Regulation on Reporting and Public Announcement of Accidents and Incidents for Nuclear Power Utilization Facilities***"). ***The notice covers the procedure, method, object of reporting and the evaluation of scale of accidents and incidents.***

Radiological Emergency Response Scheme

The radiological emergency response scheme is composed of the Central Response Committee which is chaired by the Prime Minister, the National Emergency Management Committee(NEMC), Off-site Emergency Management Center(OEMC), the Local Emergency Management Center(LEMC), the KINS-Radiological Emergency Technical Advisory Center, Korea Institute of Radiological and Medical Sciences(KIRAMS)-Radiological Emergency Medical Center**,** and the KHNP-Emergency Operation Center as shown in Figure II.11-1.

The central government has a responsibility to control and coordinate the countermeasures against radiological disaster. Especially, OEMC, which consists of experts dispatched from the central government, local governments and designated administrative organizations, has responsibility to perform coordination of management of radiological disaster and decision-making on public protective actions(sheltering, evacuation and food restriction, etc). OEMC consists of seven actual groups including Joint Public Information Center in charge of providing accurate and unified information about radiological disaster and OEMC Advisory Committee for the director of OEMC.

LEMC, established by the local governments concerned, implements the OEMC's decisions for the public protective actions.

When an accident occurs, KHNP, an operator of nuclear installation, is responsible for organizing an Emergency Operation Center and for taking measures to mitigate the consequences of the accident, to restore installations, and to protect the on-site personnel.

On the other hand, central government ***has established*** the national radiological emergency medical system for coordination and control of radiological medical services. It consists of National Radiological Emergency Medical Service Center and primary and secondary radiological emergency medical hospitals designated by the region. KIRAMS establishes Radiological Emergency Medical Center and administers national radiological emergency medical system in radiological disaster**.**

KINS organizes Radiological Emergency Technical Advisory Center, which is in charge of providing technical advice on radiological emergency response, dispatching technical advisory teams to the affected site, initiating emergency operation of ***38*** nation-wide environmental radioactivity monitoring stations in accordance with the Nationwide Environmental Radioactivity Monitoring Plan, coordination and control of off-site radiation monitoring***,*** offering radiation monitoring cars, and monitoring the response activities of the operator. It has an agreement with Nuclear·Biological ·Chemical DEFENCE COMMAND for prompt response in the initial phase of radiological emergency.

KINS also developed the ***Atomic*** Computerized Technical Advisory System for ***a*** Radiological Emergency ***(AtomCARE)***. Currently it is operated in order to effectively provide various technical supports for the public and environment protection in radiological emergencies. ***AtomCARE*** permits not only the rapid verification and evaluation of radiological emergencies and radiation impacts but also the comprehensive management of information about several measures to protect the public. Its configuration is represented in Figure II.11-2.

Protective Measures

In order to make the emergency plan immediately executable at the early phase of the accident, an emergency planning zone (EPZ) is designated for the area at a radius of 8-10 km from the nuclear installation. Intensive emergency plans such as evacuation plan are required for an EPZ. For the areas outside the EPZ, comprehensive plans are worked out. For the evacuation and indoor sheltering of the population within the EPZ, the local government designates and secures, beforehand, public establishments by regions as facilities for evacuation and indoor sheltering. These facilities are chosen in consideration of the estimated number of persons, distance, and time required for evacuation. The local government gives directions for evacuation and indoor sheltering when an accident occurs. Considering the special aspects of radiological accident, the local government and the nuclear installation operator must jointly alert the population living within a radius of 2km from the nuclear installation.

The operators of nuclear installations are responsible not only to report emergency situations to the organizations concerned, but also to provide the local government with advice and consultation on protective measures at the early phase of the accident.

If emergency situation occurs, the LEMC sets up an Emergency Medical Center and designates medical institutions to provide prompt treatment for persons overexposed to radiation. In order to prevent the thyroid exposure from radioactive iodines, the Headquarters retains potassium-iodide for emergencies and maintains a distribution system.

KHNP made an agreement with designated hospitals near the site of nuclear installation for emergency medical service, and established the Radiation Health Research Institute which conducts researches activities and incorporate the results into radiation and health physics. The institute also provides the radiological emergency medical service and the medical examination for nuclear workers and inhabitants in the nearby area.

The Director of the OEMC has a responsibility to decide on the measures to control the ingestion of contaminated foodstuffs. The Director of the NEMC and the operator of the nuclear installation shall give utmost support to the Director of the LEMC in making decisions on relevant measures. In order to secure a stable life of the population, it is necessary for the local headquarters to devise short-term food substitute, secure an emergency water supply system, and take long-term response against a prolonged emergency.

Measures for Publicity

The central government and the local governments have provided information to the public in the vicinity of the nuclear installation on nuclear disasters, evacuation routes, sheltering centers, emergency communication, and protective action guides through pamphlets and civil defense education.

Emergency Facilities and Equipments

The operator of nuclear installations must prepare emergency response facilities such as the Emergency Operations Facility, the Technical Support Center(TSC), the Operational Support Center(OSC). The SPDS is provided to the TSC. The operator is also required to set up the Plant Data Acquisition System through which information is provided to MOST and KINS.

The operator of nuclear installations shall keep and manage the equipments required by each emergency organization for the measurement and analysis of radioactivity. The operator also provides off-site emergency organizations with radioactivity measuring and analyzing equipment to perform an emergency response.

The emergency response capability and the radiological emergency response facilities of nuclear power plant are continuously checked through the periodic inspections by regulatory body and, if necessary, they are complemented.

Environmental Radiation Monitoring

The KHNP conducts environmental radiation monitoring activities ***including the environmental impact assessment based on the environmental survey plan which establishes the quality control, guideline of environmental survey and the handling of survey data. These activities are*** in accordance with the Notice No ***2004-17*** of the Minister of Science and Technology (titled, "***Regulation on Radiation Environmental Survey and Radiation Environmental Impact Assessment around Nuclear Power Utilization Facilities***").

The environmental radiation monitors are installed at about 10 stations within a 30 km radius of nuclear installations, in consideration of topography, population distribution, and atmospheric dispersion factors, and continuously monitor the gamma exposure dose rate 1 m above the ground. The monitoring system status and the radiation dose levels can be confirmed, on real time basis, in the environmental radiological laboratory and the main control room where the monitors are connected on-line. TLDs are installed at about 40 posts for measuring and assessing quarterly the cumulative gamma radiation dose within a 30 km area around nuclear installations.

The sampling points in the neighboring environment are selected with due consideration of population distribution, meteorological condition, and geographical features of the area within 30 km. The samples are, inter alia, air particulates, land samples (soil, pine needles), water samples (seawater, underground water, precipitation), seabed samples (sediment, benthos), and food samples (milk, fishes and shellfish, cereal, egg, seaweed). The sampling intervals are indicated in Table II.11-2**.**

On the other hand, KINS is continuously monitoring nationwide environmental radiation and dose rates and also it monitors routinely radiation contamination of air borne particulates, fallouts, rain, farm products, soil, water and milk for early detection of abnormal situation or symptoms and also for timely response to them.
KINS has also been operating Automated National Environmental Monitoring Network. A total ***of 38*** radiation monitoring stations are interconnected to the central monitoring station at KINS on this network. (Figure II.11-3) KINS annually provides training and education program to the technicians working at local radiation monitoring stations and conducts inter-comparison analysis with foreign institutes periodically for improving the quality of radiation monitoring.

II.11.3 Training and Exercises

The operator of nuclear installations shall periodically conduct repeated training and exercises for emergency personnel to qualify them by providing thorough knowledge of emergency duties***. The Nuclear Safety School of KINS***, the Nuclear Training Center of KAERI and the Nuclear Education Institute of KHNP operate training courses on emergency preparedness for personnel involved in an emergency response. The head of the local government formulates and implements an independent training program, considering the specialty of radiological accidents, to the personnel engaged in an emergency response.

According to Physical Protection and Radiological Emergency Act that came into effect in February 2004, central government manages the radiological emergency training**.** ***KINS conducted the regulatory inspection of the radiological emergency training program in Radiological Emergency Educational Institutes***.
Emergency exercises are held, in which on-site and off-site emergency preparedness organizations must participate, as follows:

- integrated emergency exercises, in which all on-site and off-site emergency organizations shall participate, are held at the nuclear installation site once or more every ***4*** years,
- on-site emergency exercises, in which all emergency units in nuclear power stations of two units shall participate, are held every year,
- drills, in which each emergency unit in a nuclear installation shall participate, are held every quarter, and
- for newly constructed nuclear installations at a site where other nuclear installations are in operation, an initial exercise is held to demonstrate the ability of emergency response before the rated thermal output reaches 5%.

From February 2004 when the ***Act on Physical Protection and Radiological Emergency*** come into force, the exercises in which all central government emergency organizations concerned shall participate are held at the nuclear installation site every 5 years. ***According to the Radiological Emergency Act, integrated emergency exercises, in which all emergency response groups of the nuclear power installations and off-site emergency response organizations are participating are to be held at the nuclear installation site every 4 years from every 3 years. According to the same Act, the MOST jointly with other related central administrations and local government authorities and related organizations such as, KINS, Korea Institute of Radiological and Medical Science (KIRAMS), KHNP, plans the national radiological emergency preparedness exercise, called, the "2007 Unified Emergency Exercise", at Wolsong Unit 2 from May 15 to 16, 2007, to prepare for national crisis or disaster from a radiological emergency.***

II.11.4 International Arrangements

The notification of an accident and the request of assistance from international organizations and nations concerned, are made in accordance with the procedures specified in the "Convention on the Early Notification of Nuclear Accidents" and the "Convention on the Support in Nuclear Accidents or Radiological Emergencies".

MOST and the USNRC maintain a radiological emergency cooperation scheme, by mutual consent, pursuant to the "Arrangement between USNRC and MOST for the Exchange of Technical Information and Cooperation in Regulatory and Safety Research

Matters". Between MOST and the Ministry of Economics, Trade and Industry, and the Ministry of Education, Culture, Sports, Science and Technology of Japan, there are inter-governmental agreements to maintain an early notification network to provide prompt notification when a nuclear accident occurs..

In December 2002, KINS and Radiation Monitoring Technical Center(RMTC) of China concluded a Memorandum of Understanding for exchange experts and information on environmental radiation monitoring, etc.

Table II.11-1 Elements of National Radiological Emergency Plan

Titles	Contents
1. Emergency Response Organization	• Emergency organization • Assignment of responsibility • Recovery planning
2. Emergency Classification and Response	• Types of emergencies considered in radiological disaster control • Emergency classification system • Emergency responses according to incident phases • Notification • Strengthening of the radiological disaster control system
3. Protective Measures	• Emergency planning zone • Alerting the population • Sheltering and evacuation • Medical support • Food and water control • Access control • Public information
4. Emergency Facilities and Equipment	• Reinforcement of emergency installations • Funding and technical assistance
5. Training and Exercises	• Emergency training • Emergency exercises

Table II.11-2 Environmental Radiation Monitoring in the Vicinity of NPPs

Items				frequency		No. of locations (samples)			
sample	media		Monitoring item	sampling	analysis	Kori	Wolsong	Yonggwang	Ulchin
Air	Air dose rate		Gamma ray dose rate (ERMS)	Continuous	Monthly	12	10	10	10
			Gamma ray dose rate (portable)	Monthly, Quarterly	Monthly, Quarterly	49(436)	30(120)	30(120)	22(78)
			Gamma ray dose rate (TLD)	Continuous	Quarterly	43(172)	42(168)	43(172)	43(172)
Land	Air	Particulates	Gross β	Continuous	Weekly	10(520)	10(520)	10(520)	10(520)
		Particulates, Gas	^{131}I		Weekly	10(520)	10(520)	10(520)	10(520)
		Particulates	γ radionuclides		Monthly	10(120)	10(120)	10(120)	10(120)
		CO_2	^{14}C		Monthly	-	3 (36)	-	-
		Moisture	^{3}H		Semi-monthly	-	10(240)	-	-
	Drinking Water		^{3}H, γ radionuclides	Quarterly	Quarterly	4 (16)	4 (16)	2 (8)	3 (12)
	Ground water		^{3}H, γ radionuclides	Quarterly	Quarterly	3 (12)	4 (16)	2 (8)	3 (12)
	Surface Water		^{3}H, γ radionuclides	Monthly	Monthly	3 (36)	4 (48)	2 (24)	3 (36)
	Rainfall		Gross β, ^{3}H, γ radionuclides	Monthly	Monthly	4 (48)	7 (84)	4 (48)	3 (36)
	River Sediments		γ radionuclides	Quarterly	Quarterly	4 (16)	3 (12)	2 (8)	3 (12)
	Soil		γ radionuclides (Including ^{131}I)	Semi-annually	Semi-annually	11 (22)	10 (20)	10 (20)	12 (24)
			^{90}Sr			3 (6)	3 (6)	3 (6)	3 (6)
	Milk		γ radionuclides (Including ^{131}I)	Monthly	Monthly	2 (24)	2 (24)	2 (24)	2 (24)
			^{90}Sr	Monthly	Quarterly	2 (8)	2 (8)	2 (8)	2 (8)
			^{14}C, ^{3}H[4]	Monthly	Quarterly	-	2 (8)	-	-
	Farm Products		γ radionuclides	The harvesting season	Semi-annually	3 (14)	4 (14)	6 (12)	2 (10)
			^{90}Sr			2 (8)	2 (8)	4 (8)	2 (10)
			^{14}C, ^{3}H[4]			-	3 (10)	-	-
	Surface Organism		γ radionuclides (Including ^{131}I)	Semi-annually	Semi-annually	7 (14)	4 (12)	6 (16)	4 (12)
			^{90}Sr			2 (4)	2 (4)	2 (4)	2 (4)
	Egg		γ radionuclides	Semi-annually	Semi-annually	2 (4)	2 (4)	2 (4)	2 (4)
			^{14}C, ^{3}H[4]			-	2 (4)	-	-
Sea	Seawater		Gross β, ^{3}H	Weekly	Monthly	9 (108)	4 (48)	4 (48)	4 (48)
			γ radionuclides		Quarterly	9 (36)	4 (16)	4 (16)	4 (16)
			^{90}Sr			2 (8)	2 (8)	2 (8)	2 (8)
	Marine Sediments		γ radionuclides	Semi-annually	Semi-annually	8 (16)	4 (8)	4 (8)	4 (8)
			^{90}Sr			2 (4)	2 (4)	2 (4)	2 (4)
	Fish and Invertebrates		γ radionuclides (Including ^{131}I)	Semi-annually	Semi-annually	3 (12)	4 (14)	5 (18)	3 (12)
			^{90}Sr			2 (8)	2 (8)	2 (8)	2 (4)
	Benthos		γ radionuclides	Semi-annually	Semi-annually	4 (8)	3 (6)	3 (10)	3 (6)
	Seaweeds		γ radionuclides (Including ^{131}I)	Biannual	Biannual	5 (10)	3 (6)	4 (8)	3 (6)
			^{90}Sr			2 (4)	2 (4)	2 (4)	2 (4)

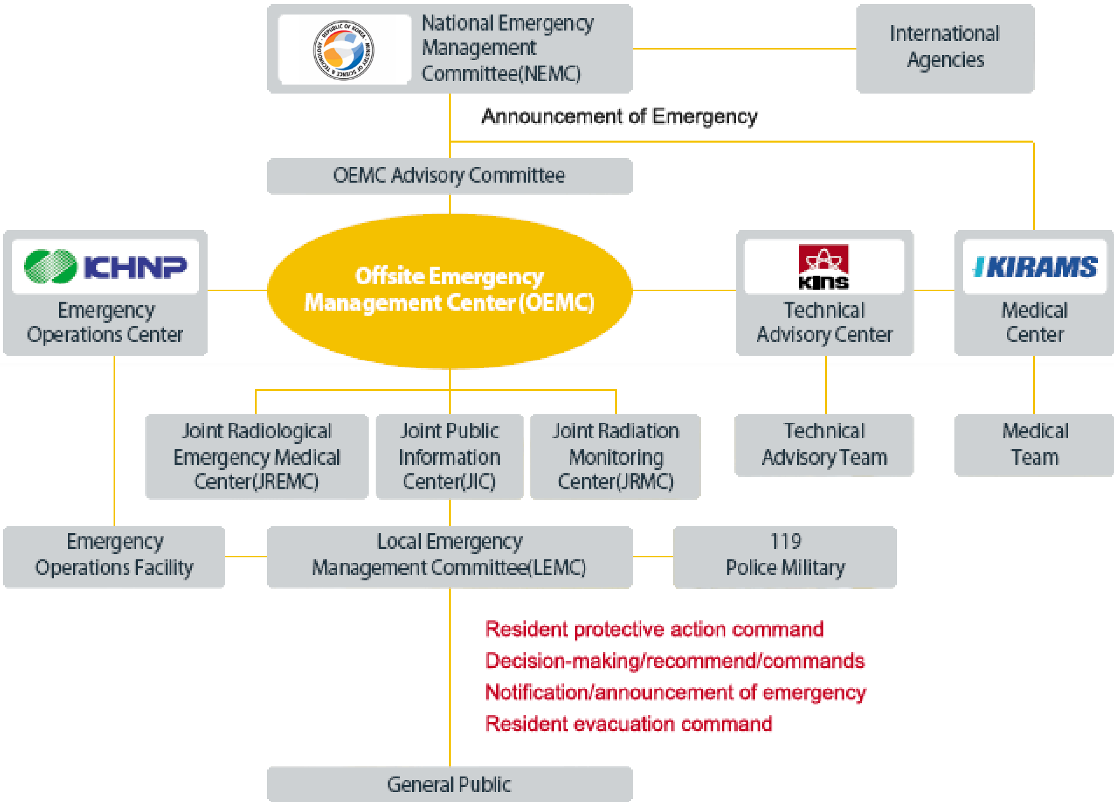
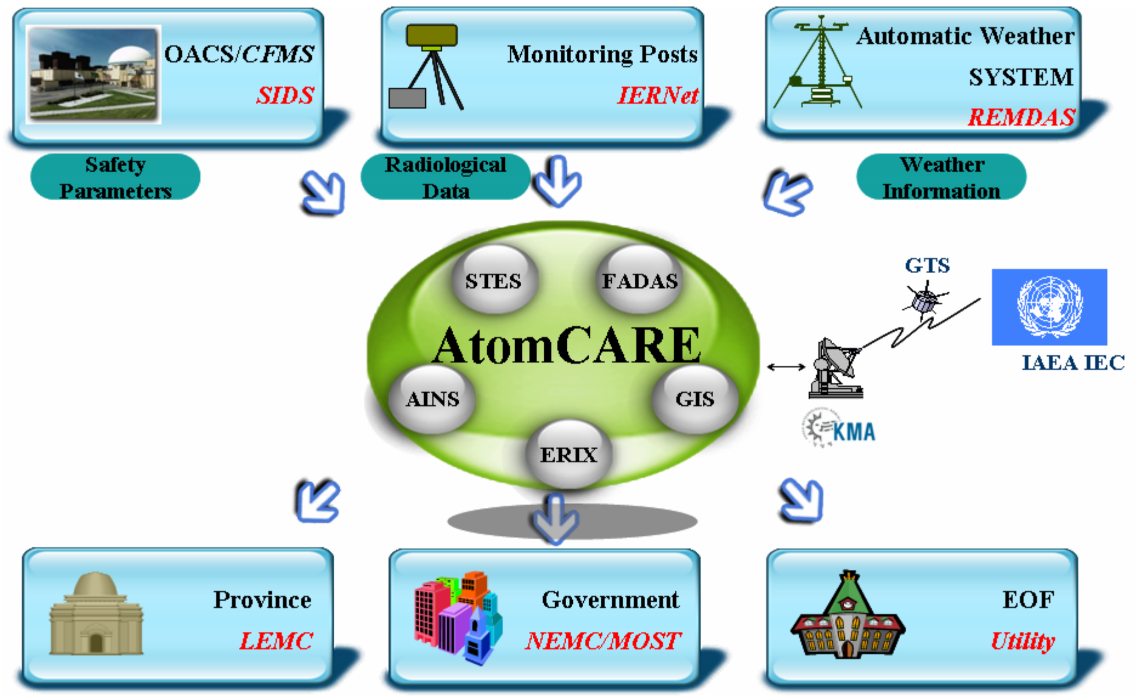


Figure II.11-1 National Radiological Emergency Response Scheme



OACS	: Operator Aid Computer System
CFMS	: Critical Function Monitoring System
SIDS	: Safety Information Display System
IERNet	: Integrated Environmental Radiation Network
REMDAS	: Radiological Emergency Management Data Acquisition System
AINS	: Automatic Information Notification System
STES	: Source Term Evaluation System
FADAS	: Following Accident Dose Assessment System
GIS	: Geographic Information System
ERIX	***: Emergency Response Information eXchange system***
KMA	: Korea Meteorological Administration
GTS	: Global Telecommunication System
LEMC	: Local Emergency Management Committee
NEMC	: National Emergency Management Committee
EOF	: Emergency Operations Facility

Figure II.11-2 *Atomic* Computerized Technical Advisory System for the Radiological Emergency (*Atom*CARE)

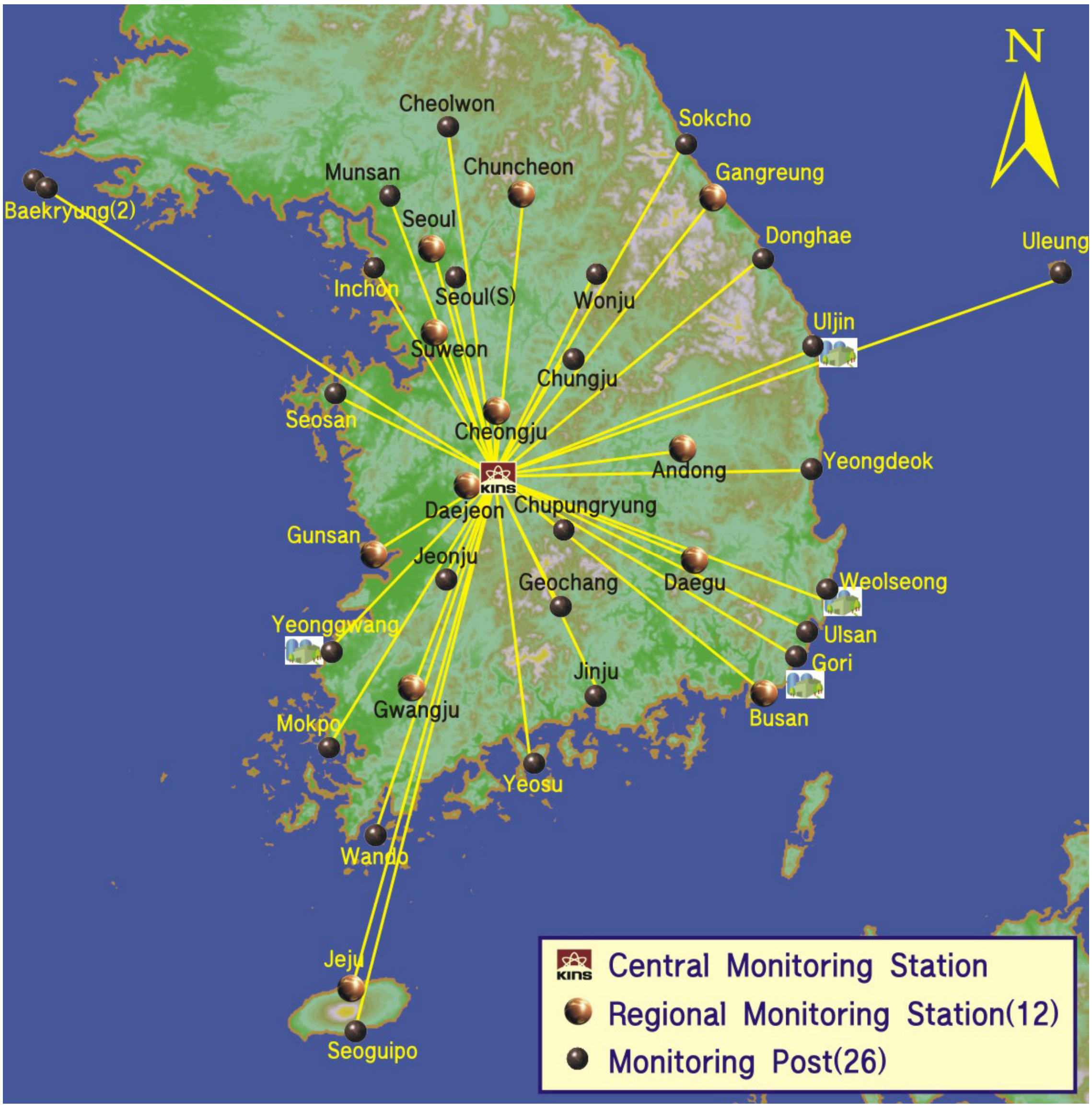


Figure II.11-3 National Environmental Radiation Monitoring Network

D. Safety of Installations

II.12 Siting (Article 17)

II.12.1 Licensing Process and Regulatory Requirements

The procedure for the site selection of nuclear installations is described in Section II.2.3. It is stipulated in the Atomic Energy Act that the siting of nuclear installations shall conform to the technical requirements prescribed by the Enforcement Decree of the same Act in such a way that it does not present any impediment to the protection of people properties and the environment against radiation hazards. As for technical standards entrusted by the same Act, the Enforcement Regulation Concerning the Technical Standards of Reactor Facilities, etc., provides 7 items: restriction on location and practicability of emergency preparedness plan, geology and earthquake, meteorology, hydrology and oceanography, man made hazard, and construction of multiple units.

The Notice No. 2000-8 of the Minister of Science and Technology (titled "Technical Standards of the Location, Structures and Components of Reactor Facilities") amended in 2000, stipulates that the relevant safety requirements set by USNRC and IAEA shall be applied, mutatis mutandis, to the regulatory requirements for siting. ***The criteria for the nearby industrial facilities, the meteorology and the hydrology for siting are provided in the Notice No. 2006-5 (title, "Negotiation on the Installations of Industrial Facility in the Proximity of the Nuclear Facilities),*** the Notice No. 2003-11 (titled, "Technical Standards for Investigation and Evaluation of the Meteorological Characteristics of Reactor Facility Sites"), and the Notice No. 2003-12 of the MOST (titled, "Technical Standards for Investigation and Evaluation of the Hydrological and Oceanic Characteristics of Reactor Facility Sites").

The Atomic Energy Act also stipulates that an exclusion area shall be established to protect human bodies, materials, and the public from radiation hazards that may result from the construction and operation of nuclear installations. Access or residence of the public ***should be restricted accordingly***.

It is also prescribed in the Environmental Impact Assessment Act to verify and evaluate non-radiological environmental impacts on the natural environment, the living environment, and the social and economic environments due to the construction and operation of nuclear installations.

II.12.2 Plan for Implementing Regulatory Requirements

KHNP shall perform safety assessments, under the provisions of the Atomic Energy Act, including the preliminary site surveys and the detailed site surveys for a proposed site. When applying for early site approval, KHNP must prepare a radiological environmental report and a site survey report, filing them with the Minister of Science and Technology. The said Minister issues an early site approval on the basis of the results of the safety review by KINS. ***However, KHNP has an option to apply for the construction permit package with evaluation of the safety of site without the procedure of an early site approval.***

Location of Site, Practicability of Emergency Preparedness Plan and Exclusion Area

For confirming the suitability of a site, it is essential to conduct a site survey and an assessment regarding the geographical and geological conditions, the present and future estimated population density, and public facilities in low population zone. Assessments are also performed regarding the adequacy of the exclusion area boundary distance, the low population zone distance, the distance between the site and the population center, and the feasibility to take proper protective actions in an emergency.

In accordance with the Atomic Energy Act, KHNP establishes an exclusion area within a specified radius from the site, as shown in Table II.12-1. In establishing the exclusion area boundary distance, 700 m was applied to a site with PWRs, at the initial stage, to be consistent with the exclusion area boundary distance applied to Kori Unit 1 on the basis of dose calculations. In the case of the site with PHWRs introduced from Canada, 914 m (1,000 yards) has been established as the exclusion area boundary distance in accordance with Canadian practices. In the case of new nuclear installations, such as Yonggwang Units 5&6, Ulchin Units 5&6, ***and recently construction was permitted for Shinkori Units 1 and 2,*** a boundary distance of 560 m has been adopted on the basis of dose calculations and newly developed technical standards. The exclusion area boundary distance has to be set up in such a way that an individual located at any point on the exclusion area boundary for 2 hours immediately following onset of the radioactive material release would not receive a total radiation dose to the whole body in excess of 0.25 Sv or a total radiation dose in excess of 3 Sv to the thyroid from iodine exposure.

Nearby Industrial Facilities

The site is selected so that nearby industrial facilities, military facilities, and transportation facilities and routes do not pose potential hazards to nuclear power plants in respect of the location and the type of the facilities, accident probability, and the distance from the nuclear installations. ***If the construction of new facilities has a possibility of adversely affecting the safety of nearby nuclear facilities under construction or in operation, the Minister of Administrative Organizations should discuss the construction permit with the Minister of Science and Technology and limit the construction, if necessary.***

As for an airport within close proximity to a site, it is essential to survey the distance between the airport and the nuclear installation, the probability of an aircraft accident, flight frequencies, and air ways, and then to evaluate the feasibility of measures to prevent an airplane collision with the nuclear installation.

Meteorology, Hydrology and Oceanography

Appropriate surveys and analysis are conducted regarding the average and extreme values of meteorological conditions and the local meteorological conditions necessary for the site selection and safety design of the nuclear installation. Appropriate analyses are also conducted regarding the potential influence of a nuclear installation on local meteorological conditions and on the topography of the site and surrounding area.

Appropriate evaluations and analyses are conducted concerning hydrological features of the site that might affect safety-related structures. These features include floods, ground water systems, surges, tsunami, and dam failure. The results are then reflected in the design of the nuclear installation. The flood history and the maximum flooding of streams and rivers are surveyed. Based on the survey, assessments are conducted regarding any potential effects from flooding or heavy rainfall, and any potential water disaster that might affect safety-related structures in the nuclear installation due to dam failures near the site. Evaluations are also conducted regarding minimum water levels to confirm the capability of the cooling water supply.

Geology, Earthquake and Geotechnical Engineering

Various surveys and analyses are conducted for the area within a radius of 320 km from a nuclear installation in such fields as topography, geology, geological structure, stratigraphy, geological tectonics and seismology. As for the area within a radius of 8 km from the nuclear installation, a more detailed investigation is conducted in specific fields of topography, geology, stratigraphy, and geological history by using geological engineering and geophysical techniques.

It is investigated to verify whether any geological disaster, for example, settlement or collapse has occurred at the site and in the area adjacent thereto, and to analyze the seismicity of the site. The results are to be reflected in the design of the nuclear installation. It is also necessary to investigate the stability of the foundation under static and dynamic load conditions, and then to evaluate whether or not the foundation holds a sufficient bearing capacity within the allowable extent of subsidence of each structures. The foundation is to be reinforced to maintain stable foundation, if necessary.

External Events Considered in the Probabilistic Safety Assessment

In conducting a probabilistic safety assessment of a nuclear installation, risk is evaluated in consideration of any external events causing functional loss of the systems, such as earthquake, fire, typhoon, or flood. In this evaluation, the instruments and structures that may be damaged from any external event are identified and the core damage frequency is estimated in consideration of damaged instruments and structures.

II.12.3 Activities to Maintain Continued Safety Acceptability of Nuclear Installations in Consideration of Site-related Factors

Monitoring and Evaluation of Non-radiological Environmental Impacts

In order to verify how the operation of nuclear installations affects the environment, KHNP conducts a periodic survey on the biological, chemical, and physical states in accordance with the guidelines for monitoring the environment around a nuclear installation. Within a radius of 8 km from the nuclear installation, the oceanic environment is investigated at more than 10 different locations, while within a radius of 10 km the land environment is investigated at more than 3 different locations.

Meteorological and Seismological Observation

KHNP makes consecutive meteorological observations to provide sufficient meteorological data to evaluate potential radiation doses to the public, due to any release of radioactive materials during normal operation or any accident of the nuclear installation. KHNP also monitors any seismic responses of safety-related facilities by the seismic monitoring systems installed in plant sites and at the facilities, so that seismic effects on the facilities can be promptly evaluated when the earthquake happens.

Epidemiological Census

In order to identify radiological effects on site personnel and on the population near nuclear installations, government took an epidemiological census of all site personnel and the population living within a radius of 3 ~ 5 km from the nuclear installation.

To ensure the accuracy and reliability of such census results, the population is classified into two groups: one for the population living in an area of 20 km from the nuclear installation and the other for the population living in remote areas of more than 20 km away. Each group is then divided into two subgroups: one for the population living in rural areas and the other for those living in cities. The census results of each subgroup are then compared with alternate subgroups.

Environmental Radioactivity Monitoring, Control of Radioactive Effluent and Dose Evaluation

The environmental radioactivity monitoring, the control of radioactive effluents and the dose evaluation are described in detail in Section II.10.2 and II.11.2.

II.12.4 International Arrangements

The Republic of Korea has not concluded any specific international agreements with foreign countries on site selection, since the Republic of Korea is a peninsula and isolated from neighboring countries. The Republic of Korea has, however, concluded agreements with foreign countries on radiological emergency preparedness, as described in Section II.11.4.

Table II.12-1 Exclusion Area Boundary Distances of Nuclear Installations

(unit : meter)

Station Name	Reactor Types	Exclusion Area Boundary Distance
Kori Unit 1, 2, 3 & 4	PWR	700
Yonggwang Unit 1, 2, 3 & 4	PWR	700
Ulchin Unit 1, 2, 3 & 4	PWR	700
Wolsong Unit 1, 2, 3 & 4	PHWR	914
Yonggwang Unit 5 & 6	PWR	560
Ulchin Unit 5 & 6	PWR	560
Shinkori Unit 1&2 (under construction)	***PWR***	***560***

II.13 Design and Construction (Article 18)

II.13.1 Licensing Procedure and Regulatory Requirements

The licensing procedure for the design and construction of nuclear installations is described in Section II.2.3.

The criteria for a CP of nuclear installations are specified in the Atomic Energy Act as follows:

- Technical capability necessary for the construction of nuclear installations shall be secured.
- The location, structures, and components of nuclear installations shall conform to the technical standards provided in the Ordinance of MOST in such a way that there may not be any impediment to the protection of human bodies, materials, and the public against radiation hazards caused by radioactive materials or materials contaminated by them.
- There shall not be any impediment to the protection of the public health and the environment against danger or injury due to radioactive materials which may accompany the construction of nuclear installations.
- The Quality Assurance program shall be in compliance with standards specified in the Notice of the Minister of Science and Technology.

The technical requirements for the location, structure, and equipment of reactor facilities are specified in the Enforcement Regulation Concerning the Technical Standards of Reactor**.** The specific regulatory requirements are prescribed in the Notice No. 2000-8 of the Minister of Science and Technology (titled "Technical Standards of the Location, Structures and Components of Reactor Facilities ").

II.13.2 Implementation of Defense-in-depth Concept

In order to assure the safety of nuclear installations, KHNP applies a multi-barrier concept based on the defense-in-depth principle, to the design and operation of nuclear installations. The following basic concepts are considered ***in the design*** in order to implement the defense-in-depth principle:

- Securing sufficient design margins,
- Fail-safe concept,
- Interlock concept,
- Securing independency, redundancy, and diversity,
- Multiple barriers concept, and
- In-service testability.

Irrespective of the reactor type, all systems, components, and structures of a nuclear installation are designed in consideration of the following internal and external events at the stage of selecting the site, as specified in the Atomic Energy Laws:

- Internal events: Loss of coolant accident, main steam and high energy line breaks, internal scattered material (missile) caused by a rotor, fire, flooding, and so on.
- External events: Earthquakes, floods, typhoons, inflammables, poisonous gas, other anticipated man-made disasters, and so on.

The nuclear installation is designed by applying the defense-in-depth principle as a safety design concept against internal and external events as mentioned above. Its major contents are as follows:

- A sufficient safety margin is secured in the design so that the probability of any design basis accident is minimized. Safety facilities are designed in terms of independency, redundancy, and diversity so that the consequences of accidents are minimized.
- Nuclear installations are designed so that even if any abnormal state occurs in the nuclear installation, due to any failures of equipment, operator errors, or combination thereof, the reactor protection system operates automatically by detecting the abnormal state and initiates the operation of the reactor shutdown system in order to prevent the abnormal state to proceed into a severe accident.
- Nuclear installations are designed so that the nuclear installation has multiple barriers, such as the fuel pellet, the fuel clad, the reactor vessel, the reactor coolant pressure boundary, and the containment building to prevent the release of any radioactive materials into the environment.

II.13.3 Prevention and Mitigation of Accidents

The followings are reflected in the design of nuclear installations to prevent any accident from occurring:

- The reactor core is designed so that in the power operating range, the net effect of the prompt inherent nuclear reactivity characteristics tends to compensate for a rapid increase in reactivity. The reactor core is also designed to assure that power oscillations which can result in conditions exceeding specified acceptable design limits are not possible or can be readily suppressed.
- The reactor coolant pressure boundary is designed to have an extremely low probability of abnormal leakage and gross rupture. If any leakage of the reactor coolant takes place, it is promptly detected to prevent against proceeding to a severe accident. It is also designed to permit periodic inspection and testing to assess the structural integrity and leak-tightness.
- The emergency core cooling system is designed to automatically provide abundant emergency core cooling following any loss of reactor coolant at a rate such that any fuel damage that could interfere with continued effective core cooling is prevented. Even if the off-site power is lost, the necessary power is to be supplied from emergency diesel generators installed in the nuclear installation. The residual heat removal system is also installed to remove the core decay heat.

The reactor protection system is installed to sense accident conditions and maintain the reactor in a safe state by automatically initiating the operation of the reactor shutdown system and the engineered safety features. The reactor protection system is designed with redundancy, diversity, and independence to assure that no single failure of any equipment or channel of the system results in loss of the intended safety functions.

The followings are considered in the design of nuclear installations to mitigate any accidents including a severe accident:

- The reactor containment is designed so that if any accident occurs, the radioactive material released from the reactor coolant pressure boundary is confined and reduced over a long period. A system is installed in the containment to control the concentration of any combustible gas as it accumulates inside. The safety features including the containment spray system are reflected in the design to lower the pressure inside the reactor containment and to eliminate radioactivity.

- The Emergency Response Facility (ERF) is installed so that if any radioactive material is accidentally released outside the nuclear installation, the radioactive effect on nearby the population and the contamination to the environment are minimized. The ERF consists of the TSC, the OSC, and the Emergency Operating Facility (EOF). The SPDS is installed in the main control room, in the TSC, and in the EOF, so that major safety parameters are promptly recognized.

The main control room is designed so that even if any serious accident occurs, the operator can safely remain to take the necessary post-accident actions. It is possible in the control room to monitor the operating parameters, the radioactivity inside and outside the reactor containment, the radiation releasing passage, and the radioactivity around the nuclear installation in order to sense the accident conditions and to take appropriate actions.

II.13.4 Application of Proven Technologies

Korea has a basic principle that technologies incorporated in a design shall be duly proven by experience or qualified by testing or analysis. All nuclear installations under construction and in operation in Korea were designed with technologies proven by operating experiences inside or outside of the country.

II.13.5 Operation in Consideration of Human Factors and Man-Machine Interface

The Atomic Energy Act stipulates that the main control room, the SPDS, and the remote control room shall be designed so that the results of analyzing and evaluating the human factors are reflected therein in order to maximize the safety and efficiency of nuclear installations. According to this provision, the contents of analyzing the feasibility and suitability of the human engineering design are included in the preliminary SAR and in the final SAR accompanying an application for a CP and an OL, respectively. The major contents of the analysis are as follows:

- In the design of the main control room, human factors are considered so that the man-machine interface is suitable for the safe operation of nuclear installations. The major factors are: working space in the main control room, environment around the working space, alarm and control facility, visual indicating facility, auditory signal facility, nameplates and their positioning, and layout of distributing boards.
- In the design of the SPDS, the human engineering principle is considered so that the system continuously provides important safety information and the reactor operators easily recognize the information by installing it in convenient places.
- The remote control room is designed in consideration of man-machine interface so that the reactor can be safely shutdown.

II.14 Operation (Article 19)

II.14.1 Licensing Procedure and Regulatory Requirements

The permit and licensing procedures for operating a nuclear installation are referred to in Section II.2.3.

The criteria for an OL for a nuclear installation are specified in the Atomic Energy Act as follows:

- Technical capability (organization, structure, education & training, qualification) necessary for the operation ***of the nuclear power reactors and related facilities*** shall be secured.
- The performance of ***the nuclear power reactors and related facilities*** shall conform to the technical requirements, as prescribed by the Ordinance of MOST, in such a way that there may not be any impediment to the protection of human bodies, materials and the public against radiation hazards caused by the radioactive materials.
- There shall not be any impediment to the protection of the public health and the environment against danger and injury due to radioactive materials which may accompany the operation of ***the nuclear reactors and related facilities, according to the Presidential Decree.***.
- The substance of a quality assurance program is to meet the criteria provided in the Ordinance of MOST.

The technical requirements in the Enforcement Decree consist of 6 articles regarding the technical capability on operation, 38 articles regarding the technical requirements for the performance of nuclear installations and 18 articles regarding the technical requirements for the Quality Assurance Program. The specific regulatory requirements ***for the reactor operations in the Technical Specifications for Operation*** are prescribed in Ministry Notice No. 2001-46 of the Science and Technology (titled, *"* ***Standard Format and Content of Technical Specifications for Operation*** *").*

II.14.2 Safety Analysis and Commissioning Program for Authorization of Initial Operation of Nuclear Installations

In order to obtain initial authorization to operate a nuclear installation, the operator shall obtain a CP and an OL from the regulatory body according to licensing procedure provided in the Atomic Energy Act. Following this, KHNP conducts comprehensive and systematic safety assessments of nuclear installations and prepares a preliminary SAR and a final SAR from the results of the safety assessments. KHNP submits the reports to MOST. The reports are reviewed by KINS, as entrusted by MOST. KINS conducts a pre-operational inspection to verify whether or not the nuclear installation is constructed in conformity with the permit conditions. The SARs, the safety assessments and the pre-operational inspection for issuing the CP and the operation license are described in detail in Section II.2.3, II.2.4, and II.9.1.

KHNP formulates and implements a commissioning program to verify that the instruments and components of the reactor coolant system can be operated in compliance with the design. The commissioning program includes the following tests: cold functional test, hot functional test, initial fuel loading test, hot functional test after loading fuel, initial critical test, low power reactor physics test, power ascension test, and initial operation test.

II.14.3 Operational Limits and Conditions

The Atomic Energy Act stipulates that the operator of a nuclear installation shall submit an operational technical specifications accompanying the application for an OL, so as to establish requisite conditions for the safe operation, and the technical specifications prescribe the details on technical guidelines. In the specifications, operational limits and conditions for the safety operation of nuclear installations, limiting safety system settings, and surveillance requirements are specified with a classification according to operational modes and systems. The technical background for each operational limits and conditions are also included in this specification.

The Standard ***Operational*** Technical Specifications on Korean Standard and Westinghouse Electric Co. (W/H) type nuclear power plants were developed ***and have been in application in some nuclear installations since November, 2006. The Standard Operational Technical Specifications on the PHWR-type reactors are under development process.*** It is outlined in Table II.14-1.

The operational limits and conditions are established with sufficient safety margins through the accident analysis in the SAR, as stated above.

II.14.4 Operation, Maintenance, Inspection and Testing Procedures

In accordance with the Enforcement Regulation Concerning the Technical Standards of Reactor, etc., KHNP, an operator of nuclear installations, prescribes in the operational technical specifications that the written procedures listed below should be prepared, observed, managed and periodically examined, and conducts the operation, maintenance, inspection and testing of nuclear installation, basing on the relevant specifications.

- Administrative Procedure,
- General Operating Procedure,
- System Operating Procedure,
- ***Test Procedure***,
- Maintenance Procedure,
- Chemistry and Radio-chemistry Control Procedure,
- Radiation Protection and Control Procedure, and
- Refueling, Security Planning, Emergency Planning, ODCM, and Fire Protection Procedure.

The procedures related to the safety of nuclear installations are to be deliberated by the PNSC and implemented after obtaining approval from the plant manager. The operational technical specifications prescribe that the same process shall apply in case that any change to the approved procedures is to be made.

II.14.5 Procedures Responding to Anticipated Operational Occurrences and Accidents

The classification of conditions of nuclear power plants is based on those developed by the American Nuclear Society. The classifications are as follows:

- Condition Ⅰ (Normal Operation),

- Condition Ⅱ (Incidents of Moderate Frequency),
- Condition Ⅲ (Infrequent Incidents), and
- Condition Ⅳ (Limiting Faults).

Incident response procedures based on event classification are as follows:

- Alert Action Procedure: Procedure describing the measures suited to an alarm
- Abnormal Operating Procedure: Procedure responding to events for Condition Ⅰ and Ⅱ events.
- Emergency Operating Procedure: Event-based and Symptom-oriented procedure to cope with Condition Ⅲ and Ⅳ, and design bases accidents.
- Severe Accident Management Guide: Accident management guide to link the Emergency Operating Procedure with the Emergency Plan.

II.14.6 Engineering and Technical Support

In order to secure safety over the lifetime of nuclear installations, the following organizations provide engineering and technical support to KHNP:

- Korea Power Engineering Co. (KOPEC): Comprehensive design engineering works including design of nuclear installations, project management, and a whole range of engineering services for construction.
- Korea Nuclear Fuel Co. (KNFC): Design and fabrication of nuclear fuel and relevant research and development activities.
- ***Korea Plant Service and Engineering Co. (KPS):*** Maintenance of electric power installations, general activities on relevant research and development, labor service, and equipment development.
- Doosan Heavy Industries Co. (DHICO): Construction of various power generating facilities including nuclear installations
- Korea Atomic Energy Research Institute (KAERI): Research and development on nuclear energy and nuclear safety technology, and establishment of policies and related work.

Additionally, KEPRI and KHNP, a subsidiary of KEPCO have internal technical support organizations and systems under its control. ***The KNETEC under KHNP is***

responsible for the support of the operation and the construction of the nuclear facilities, the advanced light-water reactor construction, the survey and analysis of nuclear technical information and the R&D & management of the radioactive wastes. The Korea Electric Power Research Institute of KEPCO is in charge of comprehensive researches and developments in all areas of electric technology including nuclear technology.

Under the contract of emergency recovery services with Westinghouse Electric Co., GEC Alstome Co., Atomic Energy of Canada, Ltd., ***and Areva NP Co. (the former Framatome ANP Co).*** KHNP receives international technical support and consultation for field works and emergency recovery of nuclear installations introduced from abroad.

II.14.7 System of Reporting Incidents to Regulatory Body

The Atomic Energy Act stipulates that the organizations concerned in nuclear activities shall immediately take all necessary safety actions and report such actions to the Minister of Science and Technology for the following cases:

- if radiation hazards occur,
- if any failure occurs in nuclear installations,
- if there is any danger in nuclear installations or radioactive materials due to earthquakes, fire or other disasters
- if Radiation Generating Devices and the radioactive material under possession is stolen, lost, or destroyed by a fire or any other incidents, or
- if the radioactive material in transportation or packing leaks or is destroyed by a fire or any other incidents.

The Notice of the Minister of Science and Technology stipulates the detailed facts on the objects, methods, and procedures of the reporting and the classifications of the incident reporting system. ***The MOST and KINS revised the details on the incidents and accidents report reflecting the operation experience in 2005 into the Notice No. 2005-7 of the Ministry of Science and Technology (titled, " Regulation on the Reporting and Disclosure of the Incidents and Accidents of Nuclear Facilities"***). The classification of incidents is based on the International Nuclear Event Scale (INES) of

IAEA. The incidents and accidents response system of utility and regulatory body are shown in Figure II.14-1. ***If an incident or accident occurs, then utilities must report it to the MOST within specified time limit and the MOST posts the related information on the internet. The MOST dispatches a special inspection team composed of KINS experts to the plant and requires the complementary corrective measures from the utilities to prevent recurrence, based on inspection report. Among 51 cases of incidents or accidents during 3 years (2004 – 2006), 3 of them were classified as class 1 (Abnormally) in INES and the others were in class 0 (Deviation).***

II.14.8 Collection, Analysis and Exchange of Operating Experience

Domestic and foreign operating experiences related to safety, cases of incidents, and the results of safety-related research are to be reflected in nuclear installations through an administrative order of the Minister of Science and Technology, or through recommendations made during regulatory inspections by resident inspectors or inspectors of KINS. KHNP ***is required to submit a report of the results*** on the implementation of the administrative orders or the recommendations to the MOST for review of its suitability. A typical example is the post-TMI action items, which have been enforced to be reflected in all nuclear installations.

In cases that it is necessary to modify nuclear installations or to change organizations or administrative matters on the basis of the results of self-assessments of domestic and foreign operating experiences, KHNP files with MOST a safety assessment report related to the modifications and changes. Entrusted by MOST, KINS reviews the report. All procedures necessary for the operation of nuclear installations must be deliberated by the PNSC and approved by the plant manager. To incorporate new technology, operating experiences, and necessary information, the procedures are examined and supplemented every 2 years.

The "Nuclear Power Plant Event Scale Evaluation Committee" ***was organized by the regulatory body*** and ***it has been in operation*** for systematic assessment and feedback of safety related operating experiences. ***In addition, the regulatory body developed the OPIS (Operational Performance Information System for Nuclear Power Plants) to synthetically manage the data related to the incidents and accidents in operating***

nuclear facilities, event evaluation results and safety performance indicators. The OPIS can provide the foundation and means to give feedbacks to the operation experience (refer to Annex F). The information in OPIS (http://opis.kins.re.kr) is composed of the date, title, power level of reactor and turbine generator before shutdown, outline, watch code and field report, which are the input items for IAEA-IRS.

KHNP formulates and implements the "Procedures for Controlling Operating and Maintenance Experience in Nuclear Installations" for the purpose of efficiently exchanging experience in operation and maintenance of nuclear installations among nuclear installations. KHNP also formulates and implements the "Procedures for Utilization and Control of Technological Information" to efficiently utilize the operating experience of foreign nuclear installations.

KHNP has joined the INPO and the World Association of Nuclear Operators to promote information exchange and mutual cooperation among operators of nuclear installations. KHNP has also become a member of Westinghouse Owner's Group, Framatome Owner's Group, CANDU Owner's Group and Combustion Engineering Owner's Group. KHNP ***makes*** technical agreements with foreign electric power companies to mutually exchange relevant technologies and experience.

KINS continuously improves e-FAST(electronic Functional Analysis & Simulation Tool) the nuclear plant analyzer which permits the quantitative analysis of operating events collected to establish and enforce the nuclear plant operating experience feedback system on a national scale. ***The*** e-FAST, a tool of analyzing the status and operational progress of any nuclear power plants under normal operation, abnormal operation, transients and accidental circumstances, is the nuclear plant simulator designed to make the interactive manipulation of equipments possible through the Graphic User Interface. ***The E-Fast was developed from 2001 to 2005 and has regularly improved for the 5 types of reactors operating in Korea, namely, OPR-1000, CANDU, Framatome, W/H 3 Loop type, and W/H 2 Loop type.***

To share and spread the information on foreign and domestic operating experiences, "The Workshop on the Operating Experience Feedback" has been annually held at KINS with other organizations since 2003.

II.14.9 Minimization, Treatment, and Storage of Radioactive Waste

The gaseous and liquid radioactive waste management systems are designed with reliability, diversity, and ***the concept of ALARA*** in collecting and treating radioactive waste generated during normal operation and anticipated operational occurrences. The gaseous and liquid effluents to the environment are to be discharged in conformity with the control limits of radioactive effluents as described in Section II.10.2. The monitoring system continuously operates to detect the radioactivities of the effluents. These systems are designed so that such release can be automatically interrupted or to be circuitously controlled if the radioactivity exceeds a alarming set point of monitoring system.

The solid radioactive waste management system have treated compactible solid waste with ***a compactor or*** a super compactor to reduce its volume, while it treats other waste matters by stabilizing or solidifying with paraffin or cement according to their property. ***Currently, R&D activity to develop a new disposable solidifying material is underway.*** In case of spent resin, it is common to dry the resin and to pack the dried resin in a High Density Poly-Ethelene container. The conditioned waste is stored in a temporary storage building before being transferred to a disposal site. ***This waste will be transferred to the disposal site when it begins its operation.***

For the spent fuel management of PWRs, the normal spent fuel storage rack in some nuclear installations has been replaced with a high density storage rack, or an additional high density storage rack is installed. For PHWRs, dry storage canisters are installed within nuclear installation sites. The amount of discharged spent fuel is reduced by employing long-term fuel cycle.

Table II.14-1 Major Contents of Standard Technical Specification

Part	Items	Major Contents
Part 1. Operation of Nuclear Installation	Use and Application	• Definition of Terminology, Logical Connect, Limiting Conditions, Surveillance Frequency, etc.
	Safety Limits	• Safety Limits and Measures in Case of Exceeding Limit
	Limiting Conditions for Operation and Surveillance Requirements	• Reactivity Control System • Power Distribution Limits • Instrumentation • Reactor Coolant System • Emergency Core Cooling System • Containment System • Plant System • Electrical Power System • Refueling Operations
	Design Characteristics	• Site, Reactor core, Fuel Storage, etc.
Part 2. Radiological Environment Control	Radiation Protection	• Reactor Installation Protection • Radiation Safety Control • Radiation Detection Instrumentation Management
	Management of Radioactive Materials, etc.	• Radioactive Waste Management • Gaseous and Liquid Effluents Monitoring System • Transportation, Storage, Handling, and Security of Nuclear Materials • Use of Radioisotope, etc.
	Environmental Protection	• Environmental Protection from Reactor Facilities
Part 3. Management Control	-	• Organization and Responsibility • Patrol and Check of Reactor Facilities • Emergency Operator's Action • Programs and Manuals • Reporting Requirement

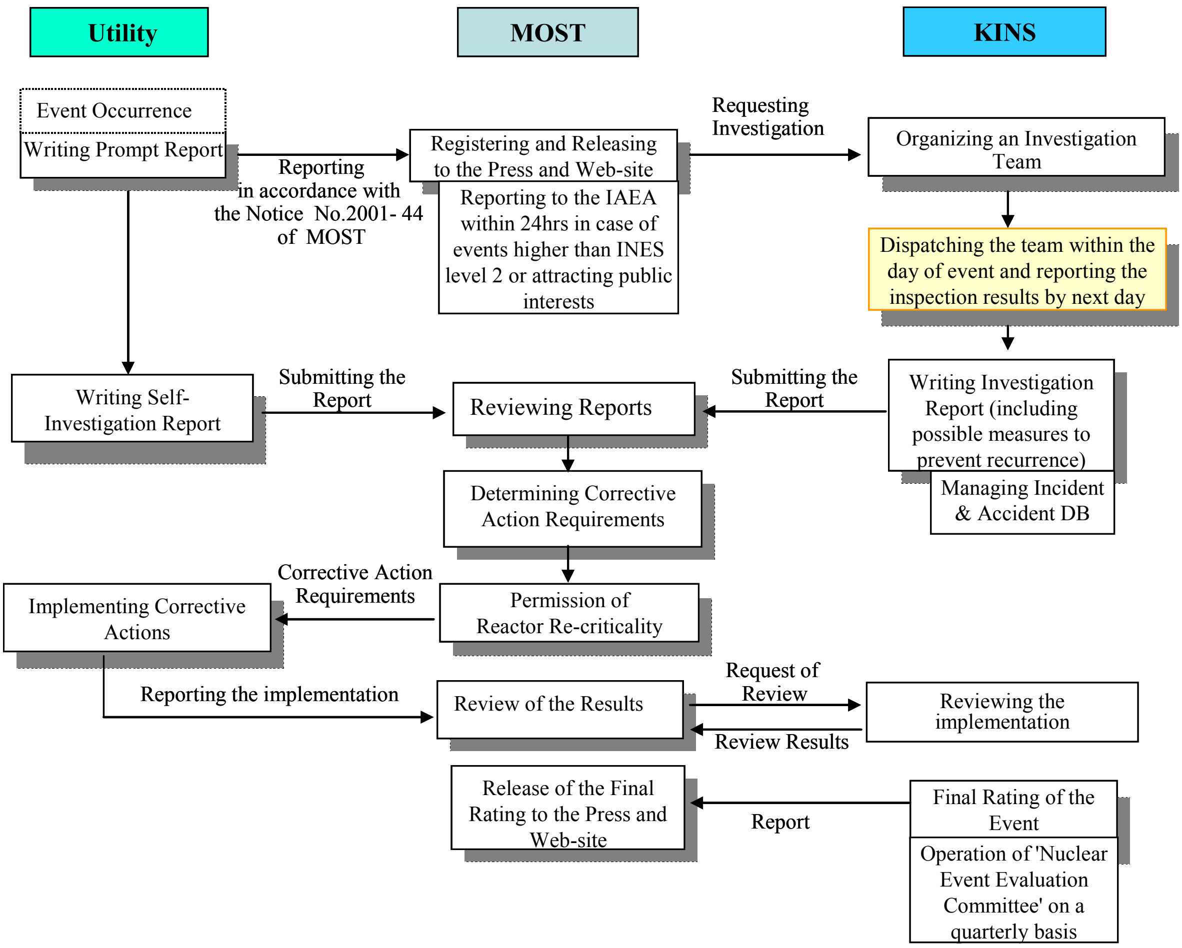


Figure II.14-1 Incidents and Accidents Response System

III. Planned Activities to Improve Safety

III.1 Implementation of PSR

In order to rectify any vulnerability in safety due to the aging of operating nuclear installations and to ensure a high level of safety commensurate with that of new installations, MOST made the legislation of a PSR system in January 2001 to establish an integrated and comprehensive safety review system in addition to the existing safety assessment and inspection for operating nuclear installations described in Section II.9.

The PSR is to be repeatedly conducted every 10 years for the basic items of 11 safety factors including equipment qualification, aging, safety performance, etc. that are specified in a guide prepared by IAEA. In the PSR, besides deterministic approach, results of Probabilistic Safety Assessment are utilized as well.

The **11** nuclear power plants, the operating periods of which have passed more than 10 years since the date of the legal enforcement, including Kori Unit 1 in the beginning of 1978 are supposed to complete the evaluations according to the older and longer order of in-service by the end of December, 2006. ***The KHNP, consequently, completed the PSR of 11 nuclear power plants with a long service (Table II.9-3). The regulatory body has completed the safety review on the utilities' assessment results from Kori Unit 1, 2, 3, 4, Wolsong Unit 1, and Yonggwang Unit 1 & 2 and been under review process on Yonggwang Unit 3 and 4. The safety review results show that each nuclear installation is operated in accordance with the current safety standards. The regulatory body also identified the recommendations to improve safety and required follow-up actions.***

The PSR gives an opportunity to check the comprehensive safety of nuclear power plants in service. It is anticipated to improve the safety of nuclear power plants through implementing the recommendations identified by the PSR. In addition, the results of PSR become an important factor in deciding continued operation and for this reason, the utility is strengthening the activities to improve safety.

III.2 Regulatory Use and *Implementation* of Risk Information

In the Policy Statement on Nuclear Safety issued in 1994, it is declared that risk-informed regulation be introduced to current regulation system. Since then, KINS ***has completed*** the research and development in parallel with trial applications regarding the regulatory use of risk information, and, as a result, confirmed that both safety and efficiency in nuclear regulation can be improved.

A study on the risk informed and performance based regulation ***was conducted*** to establish a comprehensive system for regulatory use of risk information. It reviewed the necessity of this regulatory approach, and established the objectives, direction and principles. It also ***developed*** an appropriate model for the introduction of this system considering regulatory environments and technical levels of Korea. This study particularly includes the system for monitoring the efficiency of maintenance of utility to cope with recent frequent occurrences of failures in non-nuclear system.

The specific implementation items prescribed in RIR are utilized in periodic inspections as a demonstration. RIPI (Risk Informed Periodic Inspection) is now applied to inspection of OPR 1000 (Ulchin Unit 4, 5, 6 and Yonggwang Unit 5) as a trial case. In addition, RI-ISI (Risk-Informed In-Service Inspection) and safety review on the test interval extension of certain systems using risk information are now being conducted. Related guidelines are under development.

On the other hand, KHNP is considering the plans for promoting the improvement of nuclear power plant operation using risk information of systems and components obtained through PSA for the power plants. It is also developing technology for evaluating and improving the quality of PSA. ***The KHNP also introduced MR (Maintenance Rule) which is a program for monitoring the effectiveness of maintenance and prepares for the trial applications.***

III.3 Activities for Improving the Perceived Safety

The government has implemented various activities to improve the safety perceived by the public. This is based on the realization that safety perceived by the public is as important as the engineered safety which is secured from the safety related activities

by the regulatory body and utility. The government has set up the regulatory policy goal as "The Public's Ease." The goals set in the regulatory policy can be achieved by securing the safety level accepted by the public. In this regard, the MOST announced the basic direction of regulatory policy each year as follows (refer to section I.1.1):

- *Year 2004: Attain the nuclear safety administration for the public's ease through the most advanced nuclear safety management system*

- *Year 2005: Realize the nuclear safety administration for the public's ease*

- *Year 2006: Secure the public confidence and the highest level nuclear safety through the high quality safety regulation*

To carry out these directions, KINS hosted the forum titled, "Securing the public confidence on nuclear safety regulatory body" in 2005. In the forum, the participants discussed the definition and characteristics of confidence on regulatory body. In 2006, a seminar on "How to deal with confidence and distrust on regulatory body" was held at KINS to enhance the understanding of the importance of confidence.

III.4 The Use of AtomCARE

KINS operates an Atomic Computerized Technical Advisory System for a Radiological Emergency (AtomCARE). In a normal situation, AtomCARE monitors and collects data on nationwide environmental radiation and safety information of commercial nuclear power reactors as well as a research reactor. However, in an emergency situation, AtomCARE can provide prompt and reliable technical advisory services to emergency response system through the analyses on accident status, atmospheric diffusion, radiological impacts and prediction of its consequences. By performing these kinds of functions, AtomCARE can protect the public and the environment from radiation exposure and is a backbone of the national radiological emergency plan. Currently, AtomCARE is operated as web-based system to manage data efficiently, provide information to the public and improve the reliability of nuclear safety.

National Emergency Management Agency (NEMA) completed the first stage of a project which aims to develop a government-wide emergency management network. The purpose of the network is to connect the database of all related governmental organizations and construct a cooperation system. On this project, 20 organizations, including the MOST, has signed an agreement on the utilization of emergency information and 15 organizations are linked to the database.

Upon the request from the IAEA, KINS has dispatched the AtomCARE experts to IEC (Incident and Emergency Center) in September, 2006. KINS experts have provided technical advice on the development of a data management system in the IEC. Korean government plans to cooperate with other Member States and the IAEA in setting up emergency response systems using AtomCARE technology.

IV. Measures taken for the Observations and Recommendations in Summary Report of the Third Review Meeting

IV.1 Introduction

This chapter describes relevant actions and measures in the fourth national report, taken by Korea for the observations and recommendations in the summary report at the 3rd Review Meeting of CNS.

IV.2 Observations and Contextual Factors (Summary Report Article 1 ~ 10)

1. The continuing economic deregulation of energy markets has brought significant changes in ownership and operating arrangements of some electrical utilities, including those utilities operating nuclear power plants.

Measures

KEPCO, the owner of all the power plants in Korea, transacted the reorganization of electric power industrial structure to divide its power generation sector into 6 subsidiary companies in April, 2001, in view of promoting efficiency in electric power business and maximizing the effect of services for the people with the introduction of competitive system (refer to Section II.6.1).

IV.3 Observations on Openness and Transparency (Summary Report Article 11 ~ 14)

12. Many Contracting Parties reported on good practices, including improved usage of the Internet for near real time communication and transmission of information, as well as for nuclear event databases (e.g., INES) that are open to the public.

Measures

In Korea, the Safety Performance Indicators (SPI) system was to analyze performance trend, to monitor long-term safety status of NPP operations, to allocate regulatory resources properly and to improve public confidence in

nuclear safety by providing operational information. The evaluation of SPIs is being performed once every quarter and the results are posted on the Web-site, http://opis.kins.re.kr.

IV.4 Observations on Legislative and Regulatory Framework (Summary Report Article 15 ~ 19)

15. Other Contracting Parties continue to improve their domestic rules and standards on nuclear safety or are in the process of modernizing them.

Measures

During the period from 2004 to 2006, 5 notices were newly formulated and 12 notices were amended (refer to Section II.2.1).

IV.5 Observations on Regulatory Body (Summary Report Article 20 ~ 29)

20. Many Contracting Parties reported on restructuring of their regulatory bodies and increased authority through legislative changes.

Measures

In 2005, the MOST developed the legal foundation for establishing the Korea Institute of Nuclear Nonproliferation And Control (KINAC) and for continued operation of nuclear power plants of which operation period are over their design lifetime. KINAC was established in June, 2006, as an expert organization for physical protection and effectively promoting the safeguard of nuclear facilities and nuclear materials and the control of export and import of nuclear materials. In addition, the MOST took charge of the inspections on the secondary system on which the Ministry of Commerce, Industry and Energy performed before.

22. Some Contracting Parties have taken active steps to improve the human and financial situations of their regulatory bodies.

Measures

KINS has increased its staff members from 327 at the end of 2003 to 378 at the end of 2006.

25. Accordingly, the implementation of quality management systems within regulatory bodies is expected to be reported upon at the Fourth Review Meeting.

Measures

KINS has established a quality management program based on IAEA Safety Standards Series No. GS-R-3 "The management system for facilities and activities" in order to improve the public trust and the reliability of the regulatory body (refer to Section II.8.4).

28. Many Contracting Parties stressed the importance of communication and dialogues between the regulator and the operator.

Measures

The KHNP invited competent experts from domestic and abroad and held a "Nuclear Safety Symposium" two times from 2005 to 2006. The purpose of those Symposiums was to refresh the concept on nuclear safety and search advanced methodologies in nuclear safety and plant operation technologies through the consensus of experts from government authorities, industries, universities, and research institutions and the exchange of information among those experts.

KINS has been holding the Nuclear Safety Technology Information Meetings annually since 1994 to share up-to-date information and technologies regarding nuclear safety and regulations between regulatory organizations and industries (refer to Section II.5.5). The purpose of these meetings was to enhance the common perception for the importance of nuclear safety through the mutual in-depth discussions on nuclear safety regulation issues between the regulatory body and nuclear licensees.

IV.6 Observations on Financial and Human Resources (Summary Report Article 30 ~ 34)

34. Recognizing the importance of maintaining competence in nuclear safety, several Contracting Parties indicated that their operators would have been developing and undertaking systematic programmes to compensate for expected retirements and loss of knowledge to include supporting worldwide industry research initiatives.

Measures

The KHNP, a Korean operator of nuclear installations, provides employees with professional knowledge and experiences by annually improving the educational programs to ensure safe operations of the nuclear installations according to the provisions stipulated by Atomic Energy Act (refer to Section II.6.4).

IV.7 Observations on Priority to Safety (Summary Report Article 35 ~ 43)

35. The safe operation of nuclear power plants around the world depends upon a strong and vibrant safety culture that encourages a learning organization and working environments where questioning attitudes are encouraged and real safety issues are communicated and addressed.

Measures

In order to introduce its employees the concept and importance of nuclear safety culture, the KHNP has developed educational course materials and held classes on safety culture, for more than 2 week periods in the Nuclear Power Education Institute. Also, the KHNP has been providing their nuclear power plant employees with special lectures on safety culture prepared by veteran nuclear experts and outstanding professionals. Improvement of safety culture can be achieved through analyzing the employees' work ethics, safety consciousness, and analyses on practices that affect the safe operations of nuclear installations. The fact that safe operation is achieved through fostering a good safety culture, the most economical method in running nuclear power plants, is widely acknowledged in the nuclear power sector.

43. Many safety culture assessment tools and safety management systems, which will be reported at the Fourth Review Meeting, remain under development.

Measures

The KHNP conducted researches on the improvement of safety culture from July, 2004 to August, 2005 in order to inspire its employees with safety consciousness, continuously promote the safety culture and develop safety culture performance indicators. Also, KHNP has continuously evaluated the safety consciousness of employees in all nuclear power plants with the developed safety culture performance indicators. The result of the evaluation has been reflected into the operational management and training programs for both its new and current employees.

IV.8 Observations on Human Factors (Summary Report Article 44 ~ 47)

47. Methodologies for analyzing human factor events are being further improved and reports on these improvements may be expected at the Fourth Review Meeting.

Measures

In 2006, KHNP developed web-based K-HPES to enhance the applicability of human error cases occurred during plant operations and to extend their usefulness by including near-miss accidents into the analysis (refer to Section II.7.1).

IV.9 Observations on Emergency Preparedness (Summary Report Article 48 ~ 53)

51. Contracting Parties continue to improve their emergency preparedness programmes as well as the associated exercises. They are striving to make these exercises as realistic as possible, by including all organizations that would be involved in a real event.

Measures

According to the Act on Physical Protection and Radiological Emergency, the MOST jointly with other related central administrations and local government authorities and related organizations such as, KINS, Korea Institute of Radiological and Medical Science (KIRAMS), KHNP, plans the national

radiological emergency preparedness exercise, called, the "2007 Unified Emergency Exercise", at Wolsong Unit 2 from May 15 to 16, 2007, to prepare for national crisis or disaster from a radiological emergency.

IV.10 Observations on Radiation Protection (Summary Report Article 54 ~ 56)

55. Many Contracting Parties reported on changes in their legislation and regulatory frameworks to improve their regulatory oversight over radiation protection.

Measures

The MOST has authorized the KRIA to establish and operate the RIS (Radiation workers Information System) since August, 2005. The RIS successfully demonstrated that it is able to comprehensively classify, operate, and manage the radiation exposure, health medical examination, educational & training about 30,000 workers in 3,000 radioactive source using companies through the workers' life time. The MOST has strengthened safety management for radiation workers through the close connection between the Korea Information System on Occupational Exposure (KISOE), which is under the KINS leading management part of the Radiation Safety Information System (RASIS) , and the RIS.

IV.11 Observations on Assessment and Verification (Summary Report Article 57 ~ 65)

58. PSR is considered to be in a mature state and has benefits in confirming the adequacy of the safety case, in making decisions on continued operation, in evaluating safety upgrades and improvements and in obtaining operating experience feedback. PSRs are mandatory in many countries.

Measures

The KHNP completed the PSR of 11 nuclear power plants with a long service history. The regulatory body has completed the regulatory safety review on the utilities' assessment results from Kori Unit 1, 2, 3 and 4, Wolsong Unit 1, and

Yonggwang Unit 1 and2, respectively, and been under review process on Yonggwang Unit 3 and 4.

60. Experience with the implementation of risk-informed decisionmaking can be expected at the Fourth Review Meeting.

Measures

The specific implementation items prescribed in RIR are applied to inspections as an individual demonstration. The RIPI (Risk Informed Periodic Inspection) is now applied to inspection of OPR 1000 (Ulchin Unit 4, 5 and 6 and Yonggwang Unit 5) as a trial case. In addition, the RI-ISI (Risk-Informed In-Service Inspection) and safety reviews on the period extension of certain systems using risk information are now being conducted. Related guidelines are under development.

65. Contracting Parties will report on their experience with PSAs at the Fourth Review Meeting.

Measures

Based on the PSA results, the PWR-type nuclear installations Kori Units 1, 2, 3 and 4, OPR 1000 set up an Alternate Alternating Current (AAC) and for Yonggwang Units 1 and 2, and Ulchin Units 1 and 2, KHNP is conducting the detail design to add an Alternate Alternating Current (AAC) in order to enhance capability of coping with station blackouts (refer to Section II.9.2).

IV.12 Observations on Safety of Nuclear Power Plants: Siting, Design and Construction (Summary Report Article 66 ~ 70)

70. Contracting Parties with nuclear power plants reported on the successful implementation of upgrades and safety enhancements at existing nuclear power plants and on plant life extensions.

Measures

The government reorganized the laws and formulated frameworks on safety management plan for the nuclear power plants of which operation periods are *over their design lifetimes. The laws enable the continued operation after confirming the safety through the periodic safety review which includes the life evaluation of major components, improved ageing management program and radiation environmental impacts assessment. In addition, the government established the technical standards on specific items required for safety evaluation.*

IV.13 Observations on Safety of Nuclear Power Plants: Operation (Summary Report Article 71 ~ 78)

75. Progress on operational experience feedback can be expected at the Fourth Review Meeting.

Measures

To share and disseminate the foreign and domestic operating experiences, "the Workshop on the Operating Experience Feedback," where the personnel from the government authority and nuclear licensees participated in, has been annually held at KINS since 2003.

The e-Fast system, a tool to analyze the status and operational progress, for the 5 types of reactors operating in Korea, namely, Korean standard nuclear power plant (OPR-1000) type, CANDU type, Framatome type, W/H 3 Loop type, and W/H 2 Loop type, had been developed from 2001 to 2005 and, is continuously being improved.

76. Further information on the development and implementation of severe accident management programmes (SAMP) would be welcomed at the Fourth Review Meeting.

Measures

The KHNP established the severe accident management programs for 14 units among 20 operating units and presently applies the program. The severe accident management programs are under development for 2 plants, and under planning for the remaining 4 plants, respectively.

IV.14 Final Conclusions and Recommendations (Summary Report Article 79 ~ 84)

The Third Review Meeting provided all Contracting Parties an opportunity to improve their approach to nuclear safety through a vigorous process. All contracting parties committed to a process of continuous improvement. The summary report identified areas for continuous improvement in the future, where collective effort and specific issues are needed to report in the next Fourth Review Meeting.

ANNEXES

Annex A.　List and Data on Nuclear Installations

Annex B.　Nuclear Safety Policy Statement

Annex C.　Nuclear Safety Charter

Annex D.　Policy on Severe Accident of Nuclear Power Plants

Annex E.　Campaigns for Nuclear Safety

Annex F.　Operational Performance Information System (OPIS)

Annex G.　Recent Major Events in Korea *(2004 ~ 2006)*

Annex A. List and Data on Nuclear Installations

Table A-1. Nuclear Power Plants in Operation

(As of December 2006)

Station name	Reactor Type	Capacity (MWe)	Operator (Owner)	NSSS Supplier	Start of Construction	Initial criticality	First power	Commercial operation
Kori Unit 1	PWR	587	KHNP	W/H	1971. 8	1977. 6.19	1977. 6.26	1978. 4.29
Kori Unit 2	PWR	650	KHNP	W/H	1978. 7	1983. 4. 9	1983. 4.22	1983. 7.25
Kori Unit 3	PWR	950	KHNP	W/H	1979. 6	1985. 1. 1	1985. 1.22	1985. 9.30
Kori Unit 4	PWR	950	KHNP	W/H	1979. 6	1985.10.26	1985.11.15	1986. 4.29
Wolsung Unit 1	PHWR	678.7	KHNP	AECL	1977. 6	1982.11.21	1982.12.31	1983. 4.22
Wolsung Unit 2	PHWR	700	KHNP	KHIC/ KAERI/ AECL	1991.10	1997. 1.27	1997. 4. 1	1997. 6.30
Wolsung Unit 3	PHWR	700	KHNP	KHIC/ KOPEC/ AECL	1993. 8	1998. 2.20	1998. 3.25	1998. 7. 1
Wolsung Unit 4	PHWR	700	KHNP	KHIC/ KOPEC/ AECL	1994. 2	1999.4.10	1999.5.21	1999.10. 1
Yonggwang Unit 1	PWR	950	KHNP	W/H	1980.10	1986. 1.31	1986. 3. 5	1986. 8.25
Yonggwang Unit 2	PWR	950	KHNP	W/H	1980.10	1986.10.15	1986.11.11	1987. 6.10
Yonggwang Unit 3	PWR	1,000	KHNP	KHIC/ KAERI/ ABB-CE	1989. 6	1994.10.13	1994.10.30	1995. 3.31
Yonggwang Unit 4	PWR	1,000	KHNP	KHIC/ KAERI/ ABB-CE	1989. 6	1995. 7. 7	1995. 7.18	1996. 1. 1
Ulchin Unit 1	PWR	950	KHNP	FRAMA- TOME	1981. 1	1988. 2.25	1988. 4. 7	1988. 9.10
Ulchin Unit 2	PWR	950	KHNP	FRAMA- TOME	1981. 1	1989. 2.25	1989. 4.14	1989. 9.30
Ulchin Unit 3	PWR	1,000	KHNP	KHIC/ ABB-CE	1992. 5	1997.12.21	1998. 1. 6	1998. 8.11
Ulchin Unit 4	PWR	1,000	KHNP	KHIC/ ABB-CE	1993. 7	1998.12.14	1998.12.28	1999.12.31
Yonggwang Unit 5	PWR	1,000	KHNP	DHICO/ KOPEC	1996. 9	2001.11.24	2001.12.19	2002. 5.21
Yonggwang Unit 6	PWR	1,000	KHNP	DHICO/ KOPEC	1996. 9	2002. 9. 1	2002. 9.16	2002.12.24
Ulchin Unit 5	PWR	1,000	KHNP	DHICO/ KOPEC	1999. 1	2003.11.28	2003.12.18	***2004.7.29***
Ulchin Unit6	***PWR***	***1,000***	***KHNP***	***DHICO/ KOPEC***	***1999.1***	***2004.12.16***	***2005.1.17***	***2005.4.22***

Table A-2. Nuclear Power Plants under Construction

(As of December 2006)

Station name	Reactor Type	Capacity (MWe)	Operator (Owner)	NSSS Supplier	Start of Construction	Initial criticality	First power	Commercial operation
Shinkori Unit 1	***PWR***	***1,000***	***KHNP***	***DHICO/ KOPEC***	***2005.1***	-	-	-
Shinkori Unit 2	***PWR***	***1,000***	***KHNP***	***DHICO/ KOPEC***	***2005.1***	-	-	-

Note) Glossary of Terms

ABB-CE - Asea Brown Boveri-Combustion Engineering

AECL - Atomic Energy of Canada, Limited

KAERI - Korea Atomic Energy Research Institute

KHIC - Korea Heavy Industries Co.

DHICO - Doosan Heavy Industries Co.

KHNP - Korea Hydro & Nuclear Power Co.

KOPEC - Korea Power Engineering Co.

W/H - Westinghouse Electric Co.

Annex B. Nuclear Safety Policy Statement

1. Introduction

The following declares MOST's major policies for the assurance of nuclear safety through the settlement of nuclear regulatory goals and principles to meet the growing public concern for nuclear safety and environment. The purpose of this Statement is to improve the consistency, adequacy and rationality of nuclear regulatory activities by notifying the public and concerned people in and out of the nuclear field of the Government's basic policies regarding nuclear safety.

As declared in the report titled, "Directions of Long-term Nuclear Energy Policy toward the Year 2030", which was approved at the 234th AEC in July 1994, Korean nuclear policy is aimed at establishing the safe use of nuclear energy for peaceful purposes and improving public welfare. Therefore, the assurance of nuclear safety should be given first priority in the development of nuclear power, and organizations and individuals engaged in nuclear power activities should adhere to safety principles as top priority.

The Korea public's distrust of nuclear safety has grown significantly these days due to the Chernobyl nuclear accident. Sometimes we are confronted with a vocal and often powerful anti-nuclear movement, particularly in the region where nuclear facilities will be built. Therefore, people in the nuclear field should have a more pro-active attitude in assuring nuclear safety so that the much-needed public trust and confidence can be obtained, and they should devote more effort to communicate with the public to resolve outstanding issues.

These days, nuclear safety is not a matter for one country but a world-wide concern. The "Nuclear Safety Convention" signed by IAEA member states during the 38th IAEA General Conference is one example of world-wide efforts to enhance nuclear safety. Its objectives are to establish national measures on nuclear safety and to ensure that each contracting party fulfills its obligations under the said Convention. As a result, each contracting country has an international responsibility for nuclear safety.

The Korean Government will continue to pursue its goal of achieving a high level of nuclear safety through the enhancement of safety technologies and the internationalization and rationalization of the regulatory system, recognizing that the overriding priority should be given to the assurance of nuclear safety before the development of the nuclear industry.

2. Safety Culture

The Government reaffirms that nuclear safety takes a top priority in the development of nuclear energy and that it should be of foremost concern to organizations and individuals engaged in nuclear activities. The Government also develops safety culture which was presented by the IAEA, recognizing that nuclear safety issues are more closely related to human factors rather than to technical ones, as demonstrated by two nuclear accidents, TMI and Chernobyl.

The safety of nuclear facilities can be secured through dedication to common goals for nuclear safety by organizations and individuals at all levels by giving a high priority to safety through sound thought, full knowledge and a proper sense of safety responsibility. The Government recognizes that nuclear safety is achieved not only by safety systems and strict regulations throughout the whole stages of design, construction, operation and maintenance of nuclear power plants, but also by the spread of safety culture. In meeting this commitment, the Government strives for strict regulations through the development of clear safety goals and regulatory policies. It will actively encourage safety-related research and technical development to achieve technical expertise of regulatory activities and will ensure regulatory independence and fairness by minimizing any undue pressure and interference.

Nuclear utilities establish management policies, giving a high priority to nuclear safety, and foster a working climate in which attention to safety is a matter of everyday concern. Managers encourage, praise and provide tangible rewards to employees for commendable attitudes and good practices concerning safety matters. On the contrary, when errors are committed, individuals are encouraged to report them without any concealment and to correct them to avert future problems. For repeated deficiencies in or negligent attitudes toward nuclear safety, managers take firm measures in such a way to prevent the same errors from occurring again. In this way, safety culture will be achieved through sound safety policies and full understanding of safety culture by the senior management and through proper practices and implementation by individuals engaged in the nuclear industry.

3. Regulatory Principles

The ultimate responsibility for safety of nuclear facilities rests with the licensee. This is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors and regulators.

The Government has in nature an overall responsibility for ensuring the protection of public health and the environment from radiation hazards which may occur in the development of nuclear energy. It inspects and ensures the appropriateness of the licensee's safety practices through nuclear regulations and establishes a high level of safety assurance system in order to achieve safety goals on a government level. To effectively regulate, the Government sets forth the following five principles to encourage high-safety performance.

3.1 Independence

The Government establishes the legal framework for the independent regulatory organization responsible for nuclear regulatory activities. It takes proper measures to ensure the independence of the regulatory organization, which is functionally separated by the other organizations and systems involved in the development of nuclear energy. It also ensures that the regulatory organization acts on its own objective, technical judgment without any political interference and influence from external sources.

The regulatory organization should maintain an extensive program of research and sufficient staff resources to review and audit the licensee's submittals so that it can independently verify the validity of the licensee's assertions which are critical to regulatory decisions. The regulators do their work seeking to achieve the highest standards of ethical performance and professionalism. Regulators' decisions and judgments must be based on objective, unbiased assessments, considering possible conflicting interests of those involved, and their work must be documented. Based on safety culture, the regulatory organization should support and guide the licensee in solving its problems, but only to the extent that the regulatory organization's independence is not impeded.

3.2 Openness

The purpose of nuclear regulations is to protect public safety and to ensure that all activities are legal and public. The Government maintains an open channel with the public for regulatory information so that the public can understand and rely on the regulatory process. The Government is also devoted to establishing a sound social stand on nuclear safety by making an effort to inform the public properly and openly of nuclear activities including safety matters.

The Government also develops nuclear policies based on public consensus, paying attention to the public's right to know the regulatory process. To accomplish this, the Government extends an opportunity to the public to participate in the regulatory processes and publicizes related information under the principle titled, "Openness and Democratization of Nuclear Administration".

However, the restricted information from industries or concerned individuals is protected and kept in confidence, and treated according to the provisions concerned. The Government objectively informs the public of its activities so that it may collect public opinions more soundly and properly, and it strives to get public consensus through constant communication and interaction with the regulators, licensees and the public.

3.3 Clarity

Nuclear regulations should be enforced through clear regulatory policies which are based on safety goals on a national level. There should be a coherent nexus between regulations and agency goals and objectives. Agency position should be documented to be readily understood and easily applied.

The Government endeavors to ensure that the licensee is fully informed about the regulators' policies so that the licensee can prepare for new policies in advance in order to achieve nuclear safety effectively upon implementation. In a case where a new or revised regulation is expected, the Government informs the licensee of the regulatory policies and provides guidance in advance and establishes regulatory practices to minimize the licensee's trials and errors caused by the revision of regulatory requirements.

The licensee should thoroughly observe the Atomic Energy Act, technical standards and regulatory guidance, and if there is a need to revise them or there is any unreasonable act or technical standard, the licensee should communicate its view with the regulatory organization in order to initiate any revisions.

3.4 Efficiency

The regulatory organization has the responsibility to provide the licensee and the public with the best possible management and administration of regulatory activities. To accomplish this, it must make constant efforts to evaluate and upgrade its regulatory capabilities.

The regulatory organization should possess sufficient staffs that are capable in performing regulatory activities which are closely connected with many technical areas, and the regulatory activities must be performed efficiently to contribute to the achievement of the goal of "Nuclear risk reduction".

Regulatory decisions must be made with the best use of all the resources invested in the regulatory process to minimize undue impediments.
Before regulatory decisions related to the improvement in nuclear safety are made, the nuclear risk reduction scale and economic benefits which can be gained from the improvement should be reviewed first.
To efficiently perform regulatory activities with limited capabilities and time, appropriate prioritization of regulatory activities must be made based on risks, costs, and other factors. Regulatory alternatives which minimize cost are adopted unless they increase the degree of risk, and in all cases resources should be used effectively for the improvement of nuclear safety.

3.5 Reliability

The regulatory organization endeavors to eliminate public distrust and fear of nuclear activities and obtain the public's trust and support through fair regulations based on technical and professional judgments. Regulatory decisions must be made promptly and fairly, and reliably based on the best available knowledge from research and operational experiences.

The Government obtains up-to-date technical information on nuclear safety and applies this information to regulatory activities. When regulatory requirements need to be either newly established or changed, the most suitable option is adopted after the effectiveness of its implementation and technological difficulties resulting from any changes are sufficiently reviewed.

The Government does its best to run its regulatory system efficiently and systematically, and to thoroughly enforce the regulations in order to secure the public's trust on nuclear safety systems.

4. Directions of Nuclear Safety Policy

◦ To quickly realize the establishment of safety culture and safety assurance system, each organization prepares its "Implementation Program of Safety Culture" and a regulatory body provides a systematic basis to evaluate the results of its implementation.

◦ Nuclear power plants in operation or under construction are supplemented with regulatory requirements consistently and systematically to achieve an international level of nuclear safety, taking into account the possibility of severe accidents.

◦ For the newly constructed nuclear power plants, factors which may increase the total risk caused by the construction of an additional nuclear power plant at the same site of existing ones are to be mitigated by improving the safety level at each grade as compared with that of the existing nuclear power plant. For the nuclear power plants in operation, maintenance, repair, inspection, and monitoring of the components are to be strengthened. "Periodic Safety Reevaluation" is established and implemented to reassess and supplement safety deficiencies which may be caused by the aging of the facilities and application of old technical standards.

◦ In accordance with regulatory requirement changes in and out of the country, the existing atomic energy law system is to be revised and supplemented, and related technical standards and regulatory guidance are to be maintained in order to efficiently perform regulatory activities.

- In consideration of the technical expertise required for nuclear regulatory activities, safety research should be continuously strengthened to meet the growing demand of regulatory requirements due to technical advancements in the nuclear field.

- Solutions for unresolved safety issues including generic safety issues of the nuclear power plants are promptly found and reflected in the policy. Operating record and accident and failure data are analyzed to determine the factors which affect the safety of the nuclear power plants, and efficient safety supplement measures are also established.

- The regulatory organization reviews the introduction of "Optimum Assessment & Probabilistic Assessment" for safety analyses, and encourages the licensee to introduce new technologies when and if they are considered to be reasonable safety assurance measures, as proven by their application.

- An "Overall Safety Assessment" is performed using probabilistic safety assessment and "Nuclear Regulation based on Risk" is done through sound safety regulations in consideration of cost-benefit factors.

- Quantitative safety goals and regulatory guidelines for the examination, prevention and mitigation of severe accidents are established and improved to be gradually applied to advanced nuclear power plants as well as to existing ones. In addition, design and operational safety of nuclear power plants are achieved through the measures in order to minimize human errors.

- Radiation protection is achieved by the concept, "Radiation exposure should be kept as low as reasonably achievable," taking into account economic and social circumstances, and for the individual exposure dose, introduction of radiation protection standards based on the new ICRP 60 recommendations is being favorably reviewed.

- In response to the growing public concern about nuclear safety, nuclear safety-related information and regulatory activities are open to the public through the publication of the "white paper on nuclear safety" and through the periodic release of information about accidents and failures at nuclear power plants.

5. Conclusion

The nuclear community strives for the public's proper understanding of nuclear energy and the establishment of safety culture by hearing and addressing the public's concerns with understanding and by using the collected wisdom of those involved to solve any problem together.

Nuclear safety can not be achieved in a day, but rather it is secured through the licensee's constant efforts to improve nuclear safety and through the regulator's thorough enforcement activities. The basic concept of nuclear regulations is to protect the public from radiation hazards and to pursue a "better safety performance" as allowed by the circumstances. To this end, the Government is devoted to developing a higher level of nuclear safety technology and regulatory system, and to achieving an international level of nuclear safety through participation in the "Nuclear Safety Convention"

In conclusion, the Government reaffirms that the assurance of nuclear safety is the highest duty of the regulatory organization and ensures that such an important role is performed faithfully to secure nuclear safety on behalf of the public.

September 10, 1994

Annex C. Nuclear Safety Charter

Recognizing that the peaceful use of nuclear energy contributes to national development and improvement of the quality of the people's life, and confirming that protection of the people and preservation of the environment through safe control of nuclear energy have the first and foremost priority over others, we pledge ourselves:

1. To maintain the highest standards of safety in the use of nuclear energy;
2. To release information regarding nuclear safety promptly and transparently;
3. To reflect the public opinion in formulating nuclear safety policies;
4. To assure the independence and fairness in nuclear safety regulation;
5. To strengthen research and development of technologies on nuclear safety;
6. To abide sincerely by national laws and international agreements on nuclear safety;
7. To complement and improve the nuclear safety-related legal system continuously;
8. To promote nuclear safety culture and incorporate it in our workplace.

September 6, 2001

Annex D. Policy on Severe Accident of Nuclear Power Plants

1. Background

Nuclear power plants are subject to stringent technical codes and standards in all phases of their design, construction, and operation. The probability of severe accident which could result in large off-site release of radioactive materials is very low. If it occurs, however, its social and economic effects could be very serious.

Thus, the license holders are required to take measures to minimize its possibility and, if it should occur, to take proper measures to minimize the risk of radiation exposure to the public. Hence the quantitative safety goals are to be established and implemented against severe accident.

2. Definitions of the terms

1) The term "severe accident" means the beyond design basis accident leading to core damage.

2) The term "severe accident management" means those actions taken by the plant staff during the severe accident to terminate the progress of core damage, to maintain containment performance, to minimize on-site and off-site release of radioactive materials, and to recover the plant into stable state.

3) The term "PSA update" means activities which revise probabilistic safety assessment model reflecting the latest plant status including changes of facilities and operational procedures, and perform the probabilistic safety assessment again.

4) The term "risk monitor" means a plant specific real-time analysis tool used to determine the instantaneous risk based on the actual status of the systems and components related to the activities such as preventive maintenance or periodic inspection of plant systems and components.

5) The term "PSA" means a comprehensive assessment that identifies the accident scenarios and quantifies the occurrence frequency and consequence of the accident and its effects on the public through probabilistic approach.

- Level 1 PSA identifies the sequence of events that can lead to core damage and estimates the core damage frequency.
- Level 2 PSA identifies the scenarios that can lead to radioactive release from the containment and estimates their magnitude and frequency.
- Level 3 PSA estimates the consequence of off-site release of radioactive materials in order to determine the risks to the public.

3. Policy on Severe Accident

1) Safety Goal

The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed 0.1% of the sum of prompt fatality risks resulting from all other accidents. The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed 0.1% of the sum of cancer fatality risks resulting from all other causes. To achieve above safety goals, the performance goals which are aimed at preventing the core damage and mitigating the fission product releases from the containment are to be established.

2) Probabilistic Safety Assessment

An owner of nuclear power reactor should assess the safety of the nuclear power plant through probabilistic approach to find measures which can reduce the risk as low as possible. The design and operational procedures of nuclear power plant should be reviewed and assessed to improve the capabilities for accident prevention and mitigation, especially for the accident scenarios which have relatively high probability of core damage. It should be also complemented by the cost-benefit consideration.

3) Severe Accident Prevention and Mitigation Capability

Nuclear power plant should have a capability to prevent core damage for keeping off severe accidents. Reactor containment should maintain its structural integrity and function as a barrier against fission product release to mitigate the consequence of accident, if core damage occurs.

4) Severe Accident Management Program

An owner of nuclear power reactor should establish and implement severe accident management programs. The programs should include accident management strategies, accident management organization, guidelines, training and education program, instrumentation, and analysis of essential information, etc.

Annex E.   Campaigns for Nuclear Safety

Nuclear Safety Day

Since MOST designated September 10 as the 'Nuclear Safety Day' in 1995, it regularly holds events every year to emphasize its will for safety as most priority and to inspire a safety consciousness into the workers engaged in nuclear industry and also to increase the public understanding and reliability for the safety of nuclear installations.

On the Nuclear Safety Day every year, a commemorative ceremony is held in the presence of nearly 500 persons engaged in nuclear power industry, ***including the Minister of MOST***. The preparation of commemorative events is made, with the initiative of MOST and KINS which is a nuclear regulatory expert organization, by the participation of ***26*** organizations inclusive of the KHNP, KOPEC, KAERI, etc. Various events including academic meetings, seminars, etc. are also held after the commemorative ceremony.

Each organization also designates the week which includes 'Nuclear Safety Day' as the 'Nuclear Safety Week' to hold a variety of safety promotion events such as the safety pledging rally, special lectures on safety, seminars on safety issues and human errors, etc., which can make all personnel renew their view and consciousness on safety. Furthermore, in order to help the public understanding of nuclear safety, each organization opens its facilities and safety-related activities to the public through many programs. For example, peoples are invited to participate in the environmental sampling and analysis process in NPP and radioactive waste processing works are open to the public.

Nuclear Safety Alert Day

The MOST, KINS and other organizations such as ***KAERI, KHNP, KNFC, KOPEC, KIRAMS and KINAC*** designated the first Tuesday every month as "Nuclear Safety Alert Day" in March 2003.   Each organization holds for the enhancement of nuclear safety various events such as safety meetings and conducts activities such as check-up of component and equipment of NPPs. The details of the events are subject to their own decision.

Their purpose is to re-awaken the mission and responsibility of employees for safety by providing the chance of recognition of safety awareness and thus to secure nuclear safety and public confidence.

Nuclear Safety Mark

The MOST in collaboration with Korean Nuclear Society(KNS) introduced "Nuclear Safety Mark" in 2002 to award the companies, organizations, products and technologies that significantly contributed to the enhancement of nuclear safety. Its purpose is to encourage the employees involved in safety related work. The awarded are also given various favors.

The MOST ***and KINS*** receive quarterly the applications for the 'Nuclear Safety Mark' from related organizations in three areas such as Nuclear Power Generation, Safety Research & Regulation and Radioisotope Use. The selection committee organized within KNS reviews and MOST awards those companies, organizations, products and technologies who finally get the Nuclear Safety Mark.

The organizations awarded use the Nuclear Safety Mark in their PA activities. They are provided with various favors such as special considerations when they apply for national R&D project and they are reviewed for the awards in the ceremony of Nuclear Safety Day. Up to December ***2006***, a total of ***36*** organizations, products and technologies have been awarded for ***12*** quarters.

Nuclear Safety Mark

Annex F. Operational Performance Information System (OPIS)

1. Background

There are increasing demands by the public and NGOs for more information on the incidents and accidents of nuclear power plants in Korea. The Operational Performance Information System (OPIS) was developed to provide ***various information, such as the content of events and the event evaluation results,*** in a timely and transparent manner, and thus to enhance public confidence in nuclear safety.

At the end of 2002, KINS developed a master plan to tackle the requests for the disclosure of information on nuclear safety by public and NGOs. In July, 2003, KINS began the development of a system that collects the related data. The OPIS became available to the public through the internet in February, 2004 (http://opis.kins.re.kr). In addition, an English version of the OPIS was launched in November, 2005 in order to share information with foreign related organizations.

OPIS is a web-based system which can systematically manage to a lot of operational performance data from nuclear power plants. ***By analyzing the collected data from the OPIS, various kinds of information on the safety of nuclear power plants can be obtained. Consequently, it is possible to identify the weak points of safety through the analysis of information. Corrective measures from operation experiences can be used for the fundamental data to construct 'Operation Experience Feedback System (OEFS).' Through the system, the safety of nuclear power plants can be modified regularly.***

2. Main features

OPIS database includes all the operational data collected from nuclear power plants. The system is composed of 4 sub-databases to effectively manage the different characteristics of data, operational status of all the NPPs in the world, incidents and failure report, nuclear event scale data and safety performance indicators ***(SPIs)***. The major contents of the OPIS are as follows.

2.1 Operational Status of NPPs

This provides operational status information of more than 600 NPPs in the world which are being operated, under construction and decommissioned. There is information on the number of unit for each country, design characteristics and performance for each unit.

2.2 Incidents and Failures

When an event occurs at nuclear power plant, utility reports to the regulatory body. After receiving the event report, KINS investigates the event and reports to MOST. ***This*** system provides all the documents and images related to reporting and investigation of events. It contains information of more than 500 events occurred at domestic nuclear power plants. For the users' convenience, ***it*** has several search modes available; by reactor name, time, word in the title, scale of event, etc.

2.3 Nuclear Event Scale Data

The International Nuclear Event Scale (INES) is a means designed by the IAEA and OECD/NEA for prompt communication to the public. Korea had adopted INES in 1992 and established 'Nuclear Event Evaluation Committee (NEEC)' in 1993 to classify rate of events occurred at nuclear power plants. The committee has been held on a quarterly basis since its first meeting on July 2, 1993. ***This*** provides all the documents generated during INES related activity in Korea since 1993. It has also search function for the users' convenience.

2.4 Safety Performance Indicator (SPI)

The SPI system was developed to provide operational performance of nuclear power plants to the public. At present, SPIs is composed of ***11*** indicators in 5 categories such as operational safety, multiple barrier, safety system, on-site radiation safety, off-site radiation safety. Evaluation results are 4 grades of color-coded, green, ***cyan, yellow***, orange, which represent excellent, good, normal, warning respectively for each indicator. The Korean SPIs has been evaluated for each indicator on a quarterly basis. The result of SPIs was open to the public through the OPIS web-site.

3. Future plan

OPIS will monitor the status of nuclear power plants over the world and update immediately when major changes happen. Data and information on accidents, incidents and failures will also be updated whenever it occurs. The results of nuclear event evaluation and data for safety performance indicators of nuclear power plants will be updated quarterly.

This system will be utilized as a channel for information disclosure to the public which may improve public confidence in nuclear safety. It will be also used as baseline data for operational experience feedback system after analysis and evaluation of the data collected and accumulated.

Annex G. Recent Major Events in Korea *(2004 ~ 2006)*

1. A fire in a reactor containment building

Kori Unit 4 had been in the 16th refueling outage since Feb. 27, 2006. During the replacement work of the S/G moisture separator reheater (MSR) in the reactor containment building, a small fire broke out at 05:10 on March 8. At that time, there were 18 workers in the containment building, including 11 subcontractor workers doing MSR replacement work for the three S/Gs. Three workers were working at S/G 'B'.

During the replacement work, two air conditioners and two air blowers were temporarily installed for air circulation from and to the inside of S/G. The fire occurred near the air blower, and it caused partial fire damage to the temporarily installed equipment such as air conditioners, air blowers, and other miscellaneous parts around the workplace of S/G 'B.' A subcontractor worker near S/G 'A' was the first to detect the fire, and the fire was completely extinguished approximately within 7 minutes with portable fire extinguishers. While they put out the fire, three workers inhaled some smoke, and the left wrist of one of them burned slightly. The workers were brought to the hospital immediately for a medical checkup, but their injuries were minor and they all returned home around 09:40.

From the investigation of the work site situation, such as, the design of temporary power supply system and working environment, it was judged that the fire might have occurred because an air blower was overheated. It was found that the heat from electric power cable was stronger than the capacity of the insulation. This was the first fire incident which occurred in reactor containment building in domestic NPPs. The fire was extinguished immediately, and three workers received minor injuries. Even though there was no physical damage to the nuclear power plant facility and no impact on the reactor safety due to the fire, the MOST jointly with KINS conducted a thorough investigation on the fire for the realization of the seriousness of a fire occurrence in the containment building. The results of the investigation, such as radiation alarms, the radioactivity levels in the reactor containment building and radiation exposures to the workers showed that the radiation exposure level on the workers and employees was negligible and there was no radiation influence on the environment.

2. Entering into a subcriticality due to fail-opening of the pressurizer spray valve and the inappropriate defeat of automatic safety injection during the RCS depressurization

During a plant startup at Ulchin Unit 2 following the completion of a unscheduled maintenance work for the main generator hydrogen leakage under the reactor critical condition on October 11, 2006, the RCS pressure was identified to have decreased abnormally. The operator detected that the pressure decrease was due to fail-opening of the pressurizer spray valve and took immediate actions to recover the RCS pressure by stopping operation of the related reactor coolant pump and transferring the reactor into a subcriticality condition by inserting the control rods.

Even after the operator stopped the operation of the reactor coolant pump (RCP #003PO), which supplies the fail-opened pressurizer spray valve (RCP #001VP) with spraying water flow to take action on the depressurization in the RCS, the depressurization situation continued and, in addition, he stopped the operation of another reactor coolant pump (RCP #002PO). The pressure in the RCS continuously decreased below its setpoint pressure value of 118.7 bars for safety injection after a full stop of the second RC pump operation. After 5 minutes, the operator realized that he should stop the operation of RCP #001PO instead of that of RCP #002OP. Then, he restarted the operation of RCP #002OP and stopped the operation of RCP #001PO. After the stop of RCP #001PO operation, the pressure in the RCS recovered to a normal pressure for the plant hot standby condition after a decrease in the pressure value of 111 bars.

With an abnormal depressurization condition, the operator intentionally blocked the SI signal which ought to be done during normal cooldown operation only. Even with RCP #003PO and #002PO stop, the RCS depressurization continued. During further depressurization, the operator should have activated the manual SI when the pressure decreased to the low pressure SI setpoint (118.7 bar.g) but the shift crew could not activate manual SI. And they only considered the fail-opening of spray valve and neglected to consider any other possible accidental condition in the FSAR. This was an evident and intentional inappropriate defeat of safety injection.

A detailed field investigation confirmed that the direct cause of the depressurization in the RCS was the fail-opening of one spray valve (RCP #001VP) of the two valves

and this fail-opening of the RCP #001VP was induced from the travel pin nut loosening of the spray valve. Also, the investigation on the mitigation actions taken by the reactor operator for the pressure transient identified few mistakes as follows; 1) delay in implementing a manual reactor shut down, 2) intentional blockage of the safety injection actuation signal, 3) operation of the incorrect RC pump and 4) failure in implementing a manual safety injection.

When the operator stopped RCP #001PO, the primary system recovered the normal pressure and temperature. After recovering the RCS pressure, the plant maintained in hot standby condition and the RCS pressure was maintained at 155 bar.
Upon investigation, one of the two spray valves was found to be fail-open due to loosening of the travel pin nut which comprised the pneumatic positioner of the spray valve. As a result, the travel pin was separated from the assembly which resulted in the activation of the rotary shaft arm and continuous supply of instrument air to the valve which caused the valve to fail-open. During the previous 13th overhaul, the valve positioner was replaced with a new one and the travel pin and nut were reassembled. It was estimated that there were some inferiorities in carrying out the reassembling work. There was an unaccountable loss of safety function associated with this inappropriate defeat of SI and there were a serious lack of the safety culture in the shift operators and the utility. However, there was no radiation release to the site and to the environment.

The investigation identified the causes of the operator response errors as follows; 1) deficiencies in the safety culture by not considering the safety as a top priority, 2) insufficient response procedures for the abnormal situations, 3) inadequate trainings of the correct response actions to the pressure transient situations of a pressurizer and insufficient preparation of the functions for a simulator are combined. Among the operator response errors, the violation of the requirements of the technical specifications are 1) a manual blockage of the safety injection actuation signal and 2) improper operation of the safety injection system in the low pressure condition of the RCS. After a reactor was transferred to the subcriticality condition, the reactor maintained the hot standby condition and no release of radioactive substances to on- or off-sites of nuclear power plants was confirmed.

Regarding this event, the MOST ordered nuclear licensee to reinforce the operator education and training program to prepare the related response procedures for the

abnormal conditions and to take corrective actions to isolate the safety injection function according the specified procedures.

MoST
과학기술부
http://www.most.go.kr

한국원자력안전기술원
KOREA INSTITUTE OF NUCLEAR SAFETY
http://www.kins.re.kr

한국수력원자력(주)
KOREA HYDRO & NUCLEAR POWER CO., LTD
http://www.khnp.co.kr

한국원자력연구소
KOREA ATOMIC ENERGY RESEARCH INSTITUTE
http://www.kaeri.re.kr

DOOSAN
두산중공업
http://www.doosanheavy.com

한국전력기술(주)
KOREA POWER ENGINEERING COMPANY,INC.
http://www.kopec.co.kr